Poplar Rule Curves (PRC)

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Instream Flow Needs (IFN) for Riparian Poplars in the South Saskatchewan River Basin

PART 2

Verification and Revision of the PRC

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Executive Summary

Cottonwoods are the foundation of riparian forest ecosystems in the South Saskatchewan River Basin (SSRB). These riparian poplars are dependent upon, and sensitive to, changes in streamflow regime. Research indicates that recent forest declines in the SSRB and elsewhere can be linked directly to contemporary flow regulation practices. Prescription and implementation of instream flows to protect and restore riparian cottonwood forests in the SSRB is urgently needed.

The Poplar Rule Curve (PRC) is a novel approach that is intended to meet the streamflow requirements for cottonwood survival, growth, and reproduction within the context of natural flow variability. The main strength of the PRC approach relates to its preservation of the natural timing, frequency, magnitude, and duration of streamflows required to meet riparian cottonwood needs.

In this report, PRC flows were generated for reaches of the Belly, Waterton, and St. Mary rivers where a range of impacts on riparian forests has been documented. The PRC flows were then compared with the actual regulated flow regimes along these rivers to evaluate the criteria used to calculate the PRC recommendation. The first four PRC criteria that define minimum through moderate flows to support riparian cottonwoods are verified as suitable. However, peak flows along the test reaches have not been altered to a great extent, making it impossible to verify the fifth criteria based on the occurrence of peak flow events. In theory, the flow threshold selected for use in criterion 5 must be sufficient to drive the sediment transport involved in continued channel formation and migration, and is expected to involve some extent of overbank flooding (> bankfull discharge). The 125% bankfull value is recommended only as an initial approximation that requires further consideration on a reach-specific basis.

The overall conclusion is that the proposed PRC-based flow regime should be adequate to meet the long-term hydrological needs of riparian cottonwood forests in the South Saskatchewan River Basin.

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1. Introduction:

1.1 Importance of cottonwoods and their Instream Flow Needs (IFN)

Riparian poplars (cottonwoods) are an integral part of riparian forest ecosystems in the South Saskatchewan River Basin (SSRB). Being the predominant native tree species present, cottonwoods provide essential habitat and food sources for terrestrial and aquatic wildlife as well as for many upland and migratory species. Riparian forests also influence channel forming processes by stabilizing streambanks and contributing woody debris. Cottonwoods themselves are dependent upon the riparian water table that is supplied by streamflow. Over thousands of years, these trees have become adapted to the seasonal rise and fall of riverine water levels. This has occurred to such an extent that the survival, growth, and reproduction of cottonwoods are now dependent on natural streamflow fluctuations. Cottonwoods are therefore sensitive to changes in streamflow and are particularly vulnerable to flow management projects that alter the magnitude, timing, or duration of natural river flows. Considering the ecological importance of cottonwoods and reports that link recent forest declines directly to flow regulation practices, there is an urgent need to identify appropriate Instream Flow Needs (IFN) to protect and restore riparian cottonwoods in the SSRB.

1.2 Common terminology

Gom (2001) presents background information relating to general cottonwood biology and detailed discussions of the development of the Poplar Rule Curve - IFN for riparian poplars in the SSRB. Terminology relating to flow frequencies and probabilities are defined below to assist the reader and streamline discussions.

-**return interval (RI)** (or **average recurrence interval**): the average length of time between two events of a given magnitude or larger. For example, a RI of 100 would describe a flow that would be expected to occur, on average, once in every 100 years. An abbreviation for RI is in the form Q_{RI} , for example Q_{100} indicates a discharge with a return interval of 100 years.

-**exceedence (exc)**: the probability of a given flow magnitude. A 1-in-100-year flow would have a probability of 1/100, or 0.01, or 1%, of being equaled or exceeded in any one year (this is the flow's **annual exceedence** value). Note that the exceedence is the reciprocal of the return interval (exc = 1 / RI , RI = 1 / exc).

-**weekly exceedence**: the probability of a given flow magnitude being equaled or exceeded during a particular week of any one year. For example, along rivers with seasonal variation in streamflow, a given flow magnitude will have a different weekly exceedence value for every week of the year.

-**exceedence curve**: the graphic representation of the relationship between exceedences (x-axis) and the range of flow magnitudes (y-axis) expected to occur during a specified period (for a given week = **weekly exceedence curve)** (eg: Figure 2a). An array of these two-dimensional weekly exceedence curves can be stacked together to form a three-dimensional exceedence curve 'surface' to describe changes in weekly exceedences during the growing season (eg: Figure 8).

-**Julian weeks**: based on the Julian calendar where each of the 52 weeks of the year are numbered sequentially, with Julian week 1 being equivalent to the week of January 1 to 7.

1.3 PRC concept

The Poplar Rule Curve (PRC) approach was designed to meet the flow requirements for cottonwood survival, growth and reproduction, within the context of a continuum of natural flow variability. The weekly PRC consists of somewhat flattened weekly flow exceedence curve based on the record of natural river flows during each week of the cottonwood growing season (mid-April through mid-September = Julian weeks 15 - 37). The calculation of the PRC is defined by five criteria that dictate; 1) there be no reductions to flows with natural exceedences of 90% or greater, 2) flows may not be reduced below the 90% exceedence level, 3) reduction of up to 35% of naturalized flow is permitted (note that this value was originally 25% in Gom (2001)) provided that 4) the resulting return interval shift is not greater than 50%, and 5) the maximum flow required is 125% of bankfull (Figure 1). Each of these five criteria tend to define specific portions of the PRC (Figure 2b).

1.4 Objectives of this report

The objectives of this report are to verify the utility of the PRC as developed in Gom (2001) and to revise it, as necessary, for implementation along various reaches in the SSRB.

Many different flow regimes have been implemented along river reaches in the SSRB. Accordingly, the effects on riparian cottonwood forests has been varied. Careful analysis of these trends will identify aspects of flow regimes that have been beneficial or detrimental. These findings will be compared to the PRC to evaluate its potential as a prescription to restore and maintain the long term health of riparian cottonwood forests downstream from flow regulatory structures in the SSRB, and possibly along other regulated river basins.

2. Background: Effects of regulated streamflows on riparian cottonwoods

2.1 General patterns of regulated flow regimes

The purpose of a flow regulatory structure dictates the type of flow regime it produces downstream and consequently the types of impacts it has on downstream riparian forests.

2.1.1 Generation of hydroelectric-power

The kinetic energy of running water can be harnessed to produce electricity by passing streamflow through turbines before releasing it downstream. This process alone does not necessarily consume water or change the pattern of streamflow. However, in order to generate hydroelectricity efficiently, streamflow is often stored on a daily or longer basis and released to generate power on demand. This pattern of flow regulation can cause pulsed streamflow releases downstream (Figure 3a), particularly during the morning and / or evening hours when demand for power is greatest (this diurnal pattern may not be discernable when flows are depicted using a weekly time-step). The magnitude and frequency of the pulses depend on the storage capacity of the structure and the pattern of demand for power. If the structure is large enough, it may also trap peak flows and moderate high and low flows downstream.

2.1.2 Diversions

Perhaps the oldest purpose of flow regulation has been to divert water for agricultural irrigation and various other human needs. Flow diversions vary dramatically in form and magnitude. They often utilize pumps, canals, and weirs to deliver flow away from the channel. Regardless of type, diversions permanently remove streamflow from river channels, and consequently cause streamflow to be reduced downstream (Figure 3b). The pattern and magnitude of flow depletion downstream depends on the capacity of the structure and the magnitude of natural flow. Reductions to streamflow may range from slight to complete, and are often correlated with seasonal dry periods when the demand for water is greatest.

2.1.3 Storage

Natural streamflow regimes often feature seasonal periods of high and low flow. These cycles may involve inconvenient timing or unreliable volumes of flow to satisfy human demands during part or all of the year. Thus, a common purpose of streamflow regulation is storage. To store water, a dam is used to pool streamflow in a reservoir for later use or release for downstream use. Reservoirs may be created on-stream or off-stream. On-stream reservoirs are formed when a dam is constructed across a stream, causing the upstream channel to be flooded. Offstream reservoirs are formed when flow is stored outside of the river's channel.

The construction of a dam and reservoir directly impacts a relatively small area consisting of the river channel, riparian area, and adjacent lands within the inundated zone. The indirect and much more widespread effects of a dam and reservoir relate to how they are operated. The effects of the operation of a dam can be measured hundreds of kilometers downstream. The change in flow regime resulting from dam operations depends on the storage capacity of the reservoir and the pattern of demand it is designed to satisfy. Usually the end result is that seasonal streamflow fluctuations are moderated to reduce high flows and increase low flows (Figure 3c).

2.1.4 Flood control

In addition to supplementing streamflow during dry periods, flow storage can also be used to protect downstream resources from destructively high flows. Flood control is particularly important where natural peak flows threaten low-lying settlements, bridges, or agricultural lands. Dams that function for flood control are usually large, on-stream reservoirs, capable of trapping peak streamflow and releasing it more gradually downstream. Flow regulation for the purpose of flood control tends to eliminate or substantially reduce peak flows (Figure 3d), with the side-effect of supplementing later flows. The flood protection provided by large dams extends long distances downstream and can be valued in billions of dollars.

2.1.5 Multi-use

Although the main purpose of a regulatory structure may be hydropower generation, diversion, flow storage, or flood control, it may be operated simultaneously for any combination of these purposes or other complementary objectives. For example, streamflow may also be regulated to enhance recreational activities on a reservoir or below a dam. Multiple-use flow regulation can result in any combination of the flow regime alterations previously discussed, particularly flow depletion and stabilization (Figure 3e). Alternatively, multi-use operations can also act to mitigate changes to the natural flow regime and meet IFN.

2.2 Types of flow modifications that affect riparian cottonwoods

Since riparian cottonwoods are adapted to natural patterns of streamflow (reviewed in Gom 2001), each type of regulated flow regime will affect downstream riparian cottonwoods in slightly different ways depending on how flows have been altered from their natural condition. Depending on the extent of change to the magnitude, timing, and duration of natural flow, the impact on downstream vegetation may vary from slight to severe and from temporary to permanent. Symptoms of acute stress due to sudden, extreme changes in streamflow tend to involve premature leaf-senescence (yellowing), branch die-back, or tree death. The effects of more chronic stress due to gradual, long-term changes in streamflow may not be evident for many years, and may involve reduced branch or radial growth, and diminished reproduction leading to widespread changes of population structure. Considering that a cottonwood's life-span may exceed 100 years, symptoms measurable in less than 10 to 20 years indicate catastrophic impacts.

2.2.1 Reduced or prolonged low flows

A common effect of flow regulation in the SSRB involves further reduction of naturally low flows. This can occur when the demand for water is high during periods of already naturally low streamflow.

Riparian cottonwoods are adapted to naturally occurring low flows. However, they may not be able to tolerate increased drought stress if the frequency or duration of low flows is increased. Additionally, if flows are reduced below natural minima, the occurrence of acute drought stress and tree mortality will be increased.

The extent and permanence of the damage caused to riparian cottonwood forests by drought stress tends to correlate with the severity and duration of the stress condition. Occasional, slight drought stress may cause no appreciable long-term harm to these forests, since the trees have the opportunity to recover from slight setbacks. Forests exposed to more frequent or severe stress may suffer more widespread and long-term consequences including progressive forest deterioration and reproductive failure.

In addition to maintaining healthy cottonwood forests, preventing flow reductions below natural minima is also likely to encourage the recovery of drought-stressed and declining forests. The severity of the damage will largely determine the potential for recovery, but as long as living trees are present, protection of minimum flows will promote tree survival and associated forest recovery.

2.2.2 Increased low flows

If high flows are stored for more gradual release during drier periods, natural low flows will be supplemented (Figure 3c). Initially, increases to low flows may enhance riparian cottonwood health by reducing the incidence of drought stress and promoting survival of trees in otherwise marginal areas. Thus, permanent increases to low flows are likely to result in some degree of population expansion. However, long-term changes to the extent of flow variability may also have negative consequences. During occasional periods of low flow, cottonwood roots are encouraged to grow deeper to access moisture. These deep roots tend to protect cottonwoods from drought stress during subsequent dry periods. This resiliency may be lost as root penetration is reduced in response to the elevated water table provided by supplemented low flows. Consequently, as their roots become shallower, cottonwoods may become drought stressed by low flows that were previously tolerable.

In situations where riparian forests have become acustomed to elevated low flows, natural minima are no longer adequate for maintaining downstream cottonwoods. Abrupt reduction back to natural low flow levels could cause drought stress, especially to trees in areas of forest expansion facilitated by the elevated low flows. To limit drought stress for these forests, a higher minimum low flow needs to be maintained indefinately. Alternatively, the forest may be restored to its natural state by gradually reintroducing natural flow variability over a period of several years. Consequently, areas of forest expansion may return to being only marginally suitable for cottonwoods, so some stress and decline might be expected in those areas.

2.2.3 Stabilized moderate flows

Flow regulation may involve the moderation of high and low flows, resulting in a more constant, moderate level of flow (Figure 3c).

Moderated flow regimes do not accommodate the life strategy of cottonwoods, as these trees are adapted to naturally dynamic streamflows. Stabilized, moderate flows are likely to lead to the combined effects of decreased high flows (discussed in Section 2.2.4) and increased low flows (discussed in Section 2.2.2). Stabilized streamflows tend to limit the elevational extent of the riparian forest above the water's surface as the cottonwood root systems become habituated to the stabilized water level. Consequently, the forest will become less resilient to drought stress caused by future low flows.

The dynamics of high and low streamflows drive channel forming processes that involve the erosion and deposition of sediment. In contrast, stable moderate streamflows tend to cause channel stabilization as point and lateral bars become stagnant. As a result, sediments are not transported as regularly and vegetation tends to encroach to the water's edge. This gradual elimination of barren nursery sites for cottonwood seedling establishment will threaten the long-term viability of the affected riparian forests. Seedlings that do manage to establish under a stabilized streamflow regime may be prone to drought stress because root elongation is not encouraged to connect them to the water table during periods of lower flows.

Prospects for the restoration of cottonwood forests affected by stabilized flow regimes are good. A full recovery would be expected in most cases where a natural range of flow variability was gradually reintroduced, allowing the forest to re-acclimatize over a period of years.

2.2.4 Reduced, delayed, or eliminated peak flows

Natural streamflow can be inadequate to satisfy human demand during dry periods, so regulatory structures may be operated to compensate by storing water during wetter periods for later release during dry periods (Figures 3c, 3d). Such reductions to natural peak flows can also serve to protect low lying structures from the damaging effects of flooding. Regardless of the intent, the reduction or elimination of peak flows can impact riparian cottonwoods in various ways depending on the degree and timing of flow modification.

An occasional reduction to peak flows is not likely to cause drought stress to cottonwoods because these flows usually surpass the levels required to maintain healthy tree growth. If reduced flood flows fail to recharge the riparian water table, trees in elevationally higher, more marginal areas would have an increased risk of drought stress. However, an occasional reduction to peak flows may promote the health of trees at lower elevations by lessening the scouring effects associated with flood flows.

Frequent reduction, delay, or complete elimination of peak flows (Figures 3c, 3d) is detrimental to the long-term health of riparian cottonwood forests. Natural flood flows drive channel processes involving erosion and deposition that prepare nursery sites required for successful seedling recruitment. The natural magnitude and timing of flood flows encourage establishment of seedlings higher on streambanks, thereby lessening the chances they will be washed away or buried during subsequent, moderate streamflows. Thus, modifications to peak flows may disrupt the frequency and pattern of natural cottonwood reproduction, resulting in reduced long-term viability of the affected riparian forests.

To remedy situations where peak flow modifications have already impacted cottonwood forest seedling-regeneration, natural peak flows can be reintroduced. Provided that an adequate seed source is still available, the natural frequency and occurrence of cottonwood seedling recruitment can be restored immediately. Forests that are exhibiting accelerated declines may need greater than natural rates of recruitment to expedite recovery. In these cases, peak flows may be provided to promote increases to the natural frequency of seedling recruitment and survival.

2.2.5 Abrupt changes and pulsed flows

Since riparian cottonwoods are adapted to the natural patterns of streamflow variability, artificial changes in flow can have many varied effects on downstream forests. Changes that affect cottonwoods include abrupt flow increases or decreases and flow pulsing. The effects of these changes depend on their magnitude, duration, frequency and timing relative to the pattern of natural stream flows.

Artificially rapid flow declines can lead to cottonwood drought stress. This may occur if the water table is reduced below the effective rooting zone too rapidly for root growth to keep pace. Young seedlings are most susceptible since their roots are not deeply established. However, saplings and even mature trees may become stressed if flow declines are severe. Cottonwoods may become increasingly less stress resilient if root elongation is not encouraged by gradual water table declines.

The destabilizing effect of repeated bank de-watering and re-watering can lead to increased erosion and channel incision. Susceptibility to such deterioration due to changes in river stage increases with stream gradient and progressively finer textured substrates. Excessive bank erosion can perpetually reset the cottonwood seedling establishment process and accelerate the removal of saplings and established trees. In addition to the effects of horizontal streambank erosion, vertical down-cutting or incision of the channel can lower the riparian water table. This can cause stress or die-back to trees in elevationally higher, drier areas, and result in narrowing of the forested riparian zone.

The regular, daily pulsing of flows characteristically produced downstream from hydropower generating facilities (Figure 3a) can produce artifacts in channel geomorphology and the associated riparian forests. For example, repeated pulses of similar magnitude will tend to cause erosion and deposition over a limited portion of the floodplain. This may lead to artificially structured streambanks that are either more or less stable than their natural state. Consequently, this will influence the availability and location of barren sediments necessary for cottonwood seedling establishment.

The severity and permanence of impacts resulting from abrupt flow changes or repeated flow pulsing can be highly variable. The prognosis for restoration is similarly variable. While riparian cottonwoods are able to recolinize areas relatively quickly when suitable conditions are restored (within years or decades), degradation of channel geomorphology tends to be a more permanent impact (lasting centuries or millenia). In most cases, the more severe the impact, the longer the period for recovery.

2.3 Impacts of flow regulation in the Oldman River Basin

2.3.1 Overview of Oldman River Basin

The Oldman River Basin is the southern most sub-basin in the South Saskatchewan River drainage (Figure 4). It extends north to High River, west to the Crowsnest Pass, south into Glacier International Park, and east to Grassy Lake. It includes extensive tracts of prairie where precipitation is limited and the primary land-use is agricultural. The main objective of flow regulation in the Oldman River Basin is to help ensure reliable supply to meet agricultural demands during the hot, dry summer period. The system of dams and reservoirs is operated mainly to store peak springtime flows for later use, diversion, or gradual release for downstream use. This pattern of regulation reduces the magnitude of both peak and low flows, generally resulting in a net loss of water from the river system.

Three riparian cottonwood species occur on floodplains in the Oldman River Basin. Each has slightly different life-history characteristics that suit it to its particular geographic range. *Populus deltoides* (plains cottonwood) occupies the eastern half of the Oldman River Basin, while *P. balsamifera* (balsam poplar) and *P. angustifolia* (narrowleaf cottonwood) occur to the west and north. All of these species can interbreed to produce hybrids wherever their ranges overlap (Figure 5). An additional species, the black cottonwood (*P. trichocarpa*), is nearly indistinguishable from *P. balsamifera* and usually occurs west of the continental divide.

As in the other sub-basins, each of the tributaries of the Oldman watershed have been affected by different combinations of flow regulatory structures (Figure 4) for varying lengths of time. Major regulatory structures include the Oldman River Dam and Reservoir (operating since 1992), Waterton Dam and Reservoir (since 1964), Belly River Diversion Weir (since 1935), and St. Mary Dam and Reservoir (since 1951). These projects, together with more than a dozen other structures, supply water directly or indirectly to more than nine irrigation districts and other water users in the Oldman River Basin.

The Oldman River Basin offers valuable opportunities for researching the effects of flow regulation on riparian cottonwoods. It contains several comparable tributaries with various types of flow regulation and severity of impacts. Additionally, because much of the region is semi-arid, changes in riparian vegetation are more directly attributed to streamflow regime.

2.3.2 Approaches for investigating the impacts of flow regulation

To investigate the effects of a particular flow regime on a riparian forest, the condition of the forest when affected by natural versus altered flow regimes needs to be compared. This type of comparison can be made directly, between the conditions of one reach before and after regulation, or indirectly, between the condition of an impacted reach and a non-impacted (natural) equivalent. While direct comparisons tend to produce the most confident assessments, indirect comparisons are often necessary since records describing pre-impact conditions are rarely available. Common indirect comparisons include those made upstream versus downstream of a flow-regulatory structure, or between comparable regulated and non-regulated river reaches. To ensure that variations detected by these comparisons are due to differences in flow regime, the context of the forests being compared must be as similar as possible. Differences between those forests may then be reasonably attributed to the associated differences in flow regime.

Direct comparison of pre- vs. post-regulated conditions

The most accurate way to determine the effect of an altered flow regime is to directly compare the condition of a forest affected by that flow regime with the condition of that same forest prior to alteration. This type of pre- versus post-regulation comparison is appropriate where a forest was studied or described extensively prior to flow modification. The approach is limited by the length of time required for the effects of regulation to become evident (many years or decades) and the compounding effects of ongoing flow modifications. Thus, pre- versus post-regulation comparisons are most useful where included as part of long-term monitoring programs.

Where a detailed, pre-regulation description of the forest is not available, historic archives including photographs, land survey records, and anecdotal accounts may assist in at least partially reconstructing the pre-regulation condition of a riparian forest. Descriptions of riparian forests in the SSRB before European contact are rare and generally sketchy. The first comprehensive survey of riparian forest abundance in southern Alberta was conducted by George M. Dawson in 1881 through 1884 (Dawson 1885). His map of the region (Figure 6) indicates that extensive tracts of cottonwood forests existed along most of the rivers in the Oldman River Basin. The exception was the lower portion of the St. Mary River and middle portion of the Belly River, where forests were generally sparse or discontinuous. By consulting these initial assessments and comparing aerial photographs taken in the 1950's and 1980's, Bradley et al. (1991) detected declines along reaches of the St. Mary, Waterton, and Oldman rivers, and minor declines to slight increases in forest abundance along the Belly River (Table 1). Similar trends were confirmed in more recent photographs from 1997 and 1999 analyzed for this project (Table 1).

Indirect comparison of regulated vs. equivalent natural conditions

When the pre-regulated (natural) condition of a forest is largely unknown, it is necessary to compare a regulated reach to a different non-regulated reach. The information gained from this type of comparison will be the most accurate where the two river reaches being compared are nearly identical. Different rivers can vary dramatically in geomorphology, natural flow regime, climate, and tree species present. Thus, affected and unaffected reaches along the same river are preferred for comparison to reduce differences due to across-stream variability. Typically, an unaffected reach is selected upstream and an affected one is chosen downstream relative to a flow-regulatory structure.

A simple upstream versus downstream comparison is not always appropriate because comparable reaches are not always available along the same river. This may be due to a shortage of upstream reaches, interference caused by additional regulatory structures, or progressive geomorphic differences in the downstream environment. In cases such as these, it may be necessary to compare a regulated reach to a free-flowing (non-regulated, natural) one along a different river. To do this, it is important to select intrinsically similar reaches for comparison to ensure that trends can be attributed to differences in flow regime rather than other factors.

The effects of flow regulation on cottonwood abundance have been documented along the St. Mary, Belly, and Waterton rivers by Rood and Heinze-Milne (1989), Bradley et al. (1991), Reid et al. (1992), and Rood et al. (1995). These studies have compared riparian forests pre- versus post-regulation, upstream versus downstream of flow-regulatory structures, and along regulated versus parallel, non-regulated river reaches. The changes in cottonwood forest abundance detected in these studies are useful to index the effects of altered streamflow regimes.

2.3.3 Effects of flow regulation along the Belly River

The Belly River is a relatively small tributary of the Oldman River Basin. Its peak weekly flow averages only about 40 m^3/s, less than half that of the Waterton or St. Mary rivers. Despite this disparity in magnitude of flow, the Belly River floodplain is at least as wide, or wider than those of the Waterton and St. Mary rivers (Table 1). Along most of its length, the channel of the Belly River freely meanders within its wide floodplain while the Waterton and St. Mary river channels tend to be more constrained.

Dawson (1885) reported moderate to very dense riparian woodlands along the upper part of the Belly River and scattered groves in the middle portion, above the confluence with the Waterton River (Figure 6, Table 1). About 50 years later, in 1935, the Belly River Diversion Weir (BRDW) became operational. After more than 50 years of flow-regulation, downstream cottonwoods have remained relatively healthy and their abundance along previously sparse reaches has even increased (Table 2).

To understand the pattern of flow-regulation created by the BRDW and its effects on downstream vegetation, recorded actual flows and reconstructed naturalized flows (the sources of these data are described in Section 3.1.2) can be compared upstream and downstream from the weir. As shown in the annual weekly flow hydrographs for 1975-1978 (Figure 7), diversion at the BRDW has caused reductions to downstream streamflows typical of diversion-affected flow regimes (Figure 3b). Since the BRDW is a relatively small structure compared to the major dams on the Waterton and St. Mary rivers, the weir has had relatively little effect on high springtime peak flows, such as occurred in 1975 (Figure 7). However, the weir has caused more significant reductions to moderate and lower flows (those with higher exceedences) throughout the growing season. This trend is seen by comparing the exceedence curve surfaces of naturalized and actual flows, upstream (Figure 8) and downstream (Figure 9) from the BRDW. Although the actual volume diverted from more moderate and lower flows is small, this amount is proportionally large when compared to the smaller size of the Belly River.

It is not known when the sparsely forested reach reported by Dawson in the 1880's (Figure 6) became the relatively dense woodland observed in air photos taken since 1950 (Table 1). Therefore, it is not possible to credit BRDW operations for this increase. Changes since the 1950's can be analyzed by comparing series of air photos. To quantify woodland abundance, two-dimensional areas and lineal distances have been measured by various researchers to assess changes over time (Table 2). This research has concluded that woodlands along the upstream reach of the Belly River have remained generally unchanged since the 1950's. Along the downstream reach, the lineal extent has not changed, however, the two-dimensional area has increased between 0% (Rood and Heinze-Milne 1989) and more than 50% (Rood et al. 1995). Reid et al. (1992) also examined differences in general canopy health and stand composition between 1951 and 1990. They reported that woodland increases were due largely to the expansion of closed canopy communities (Figure 10). They also observed that poplar stands in the downstream reach were decidedly less healthy than in the upstream reach. Between 1 and 2% and up to 15% of the trees exhibited some crown dieback. Signs of chronic drought stress including the die-back of terminal branches and dead standing trunks were evident in the downstream reach but not in the upstream groves.

The exact role that flow-regulation has played in changing riparian woodland abundances and health downstream from the BRDW is not clearly understood. The expansion of existing woodlands and increasingly closed canopy-type, suggest that the magnitude of flow-reductions downstream from the BRDW has not caused acute / lethal drought stress. However, the widespread symptoms of branch dieback indicate a more chronic level of drought stress. Simultaneous observations of both expansion and drought-stress suggest that the forest is becoming adjusted to the new, regulated pattern of streamflow. These adjustments might include root elongation by established poplars to reach a slightly lowered water table, and sucker or seedling colonization of the floodplain substrates revealed by lowered flows. Because the Belly River is a small channel in a broad floodplain, it is difficult to predict whether proportionally larger flow reductions along larger streams in more confined contexts would cause similar reactions in their streamside woodlands.

2.3.4 Effects of flow regulation along the Waterton River

Natural annual peak flows for the Waterton River average about 80 m^3/s, about twice the magnitude of those along the nearby Belly River. However, the width of the Waterton River floodplain is approximately equivalent to that of the Belly (Table 1). The Waterton Dam and its associated reservoir have been in operation since 1964. Although the Waterton Dam does not substantially attenuate high peak flows, such as occurred in 1975 (Figure 11), it has caused significant reductions to moderate and lower flows and has caused abrupt reductions following high flood peaks. Compared to the relatively unaltered flows upstream of the Waterton Dam (Figure 12), downstream reductions have affected flows across the full range of exceedences and in particular have caused reductions to already low flows in the 80 to 100% exceedence range (Figure 13). Although flow patterns downstream from the Waterton Dam mainly resemble the generalized diversion-affected flow regime depicted in Figure 3b, the storage capacity of the Waterton Reservoir can cause natural low flows to be supplemented later in the season as generalized in Figure 3c.

In the 1880's, G.M. Dawson (1885) reported that riparian woodlands were present along the full length of the Waterton River (Figure 6). Compared to present distributions, there seems to have been a slight decrease in the extent of woodlands along the Waterton River, particularly along the lower portion (Table 1). To quantify these changes, various researchers have compared air photo series from the 1950's (prior to flow-regulation) to those from the 1980's and 1990's along reaches upstream and downstream from the Waterton Dam (Bradley et al. 1991, Reid et al. 1992, Rood & Heinze-Milne 1989, Rood et al. 1995). According to the combined analyses of lineal distances and two-dimensional areas from 1951 to 1981, the extent and abundance of cottonwood forests have declined slightly upstream from the Waterton Dam and more severely downstream.

The variability in measures of forest abundance may relate to how different canopy-types have been classified. Reid et al. (1992) found that although overall forested area remained relatively constant upstream and downstream from 1951 to 1990, the canopies downstream were becoming more open (Figure 10), suggesting gradual declines within established groves. They also reported that downstream poplars were generally less healthy, showing signs of both chronic and acute drought stress. Other field surveys made between 1988 and 1991 also reported considerable branch and crown die-back and numerous decrepit groves (Rood et al. 1995).

Based on these assessments, the regulated flow regime below the Waterton River Dam is believed to have caused moderate negative impacts on the downstream cottonwood forest. Signs of chronic drought stress together with declines in canopy vigor suggest that flows have been inadequate during the cottonwood growing season. Signs of acute drought stress and general declines in forest abundance are symptomatic that flow-reductions during naturally dry years like 1977 (shown in Figure 11) have, on occasion, dropped streamflow below a lethal threshold.

In addition to impacting mature trees, regulated flows downstream from the Waterton Dam are probably also interfering with cottonwood reproductive processes. Although peak flows have not been substantially attenuated, the abrupt flow reductions following peak flows are not conducive to seedling establishment (Rood and Heinze-Milne 1989). Inadequate flows during the summer period are also likely to cause drought stress and mortality of any surviving seedlings. The long-term effects of reduced seedling-based replenishment, although not currently obvious, can significantly impact cottonwood forest populations over extended periods of time.

2.3.5 Effects of flow regulation along the St. Mary River

The St. Mary River's average annual peak flow of approximately 90 m^3/s is comparable to that of the Waterton and about twice that of the Belly River. The upper third of the St. Mary River's channel (to the confluence of Lee Creek) is typically freely meandering within a moderately wide floodplain that is comparable in dimensions with that of the Waterton and Belly rivers. The lower portion of the St. Mary River is confined by steep-walled canyons that limit the extent of the floodplain and associated riparian forests. In the 1880's G.M. Dawson (1885) reported that riparian woodlands occurred continuously along the upper part of the St. Mary River and along Lee Creek but were scattered and sparse along the lower part of the St. Mary River downstream from the inflow of Lee Creek and upstream from the inflow of Pothole Creek (Figure 6). These basic differences in woodland abundances are likely related to the geomorphic constraints of floodplain availability, but may also be accentuated by the increasingly semi-arid climate along the downstream reach (Figure 5), making the lower portion of the St. Mary River intrinsically less hospitable to riparian forests.

The St. Mary River originates in Montana and its drainage includes several large lakes in Glacier National Park. These large bodies of water naturally have a moderating effect on the downstream flow regime. Additionally, the outflow from Lake Sherburne has been flow-regulated since 1919 as part of the Milk River Project to deliver water for irrigation in north-central Montana. In

Alberta, the main regulatory structure on the St. Mary River is the St. Mary Dam, which became operational in 1951. Its on-stream reservoir extends upstream to the confluence of Lee Creek, inundating the entire floodplain to that point. The size of the St. Mary Reservoir allows it to store a considerable portion of the river's flow, but peak flood flows have not been dramatically altered (Rood et al. 1995). The annual weekly flow hydrographs from 1975 through 1978 (Figure 14) show examples of how the St. Mary Dam typically has caused significant reductions during average flow years (ie: 1976 and 1978) and extreme reductions during low flow years (ie: 1977). Other features of the regulated regime along the lower portion of the St. Mary River include abrupt reductions immediately following peak flows (ie: 1975 - Figure 14) and artificially elevated flows toward the end of the growing season. The weekly exceedence curve surfaces comparing regulated to naturalized flows along the downstream reach (Figure 16) clearly show significant reductions across the full range of exceedence during nearly all weeks of the growing season. Interestingly, flow reductions made upstream from the St. Mary Dam (Figure 15) affect a more extensive range of exceedences than reductions downstream from the Waterton Dam (Figure 13).

Reductions to riparian cottonwood forest abundance downstream from the St. Mary Dam have been widely documented (Bradley et al. 1991, Reid et al. 1992, Rood & Heinze-Milne 1989, Rood et al. 1995). Forest declines ranging from 50% to more than 70% (Table 2), have occurred gradually since 1951 (Rood et al. 1995). The progressive nature of this decline suggests that chronic drought stress is involved. Additionally, the rapid rate of decline relative to the long life-span (greater than 100 years) of cottonwoods indicates that the severity of the drought stress has also been acute, causing accelerated mortality of mature trees. Combined chronic and acute drought stresses have probably resulted from excessive reductions to natural flows across the full range of exceedence. Since the moisture requirements for recruitment of seedlings and survival of saplings are even more stringent than for mature tree survival, it is reasonable to postulate that replenishment has also been minimal during this period (Rood et al. 1995). Since cottonwoods were already historically sparse along the downstream portion of the St. Mary River (Dawson 1885, Figure 6), this reach appears to only be marginally suitable for riparian forests, making these populations especially vulnerable to alterations of streamflow.

3. Evaluating the PRC

3.1 Generating PRC flows for test reaches in the Oldman River Basin

3.1.1 Introduction to the PRC

The goal of the PRC approach, as it was drafted in Part 1 of this report (Gom 2001), was to meet the minimum, moderate, and high streamflow requirements of riparian cottonwoods within the context of natural weekly patterns of flow variability.

The first step in building the PRC was to define key minimum, moderate, and high streamflows that are important to riparian cottonwoods. Minimum flows required for the survival and maintenance of riparian cottonwoods have been estimated at between 40 and 60% of average weekly flow (Stromberg and Patten 1991). Moderate flows required for cottonwood growth and development have been estimated at 100% of average natural weekly flow (Stromberg and Patten 1990, Stromberg and Patten 1996). High flows that are associated with 'fringe' seedling establishment naturally occur about once in 5 to 10 years (Mahoney and Rood 1998), and those associated with 'general' seedling establishment events naturally occur only about once in 30 to 50 years (Cordes et al. 1997, Hughes 1994, Rood and Mahoney 1991, Stromberg et al. 1993). Additionally, bankfull discharge is recognized as a threshold conducive to cottonwood seedling replenishment (Auble et al. 1997, Bradley 1982, Howe and Knopf 1991, Johnson 1992). Peak flows of 125% bankfull are thought to be instrumental in driving channel and floodplain processes important for creating seedling nursery sites (Richter and Richter 2000). However, the flow magnitude required for channel maintenance increases with the coarseness of the bed material. For example, flows up to 130% and 160% bankfull have been reported as important for transporting bedload along coarser-substrate streams (Emmett & Wolman 2001, Andrews & Nankervis 1995).

The weekly PRC is a composite of naturalized flow exceedence curve relationships and threshold-based decisions (Figure 1) that were calibrated based on the general flow requirements of riparian cottonwoods. The minimum flow requirement for 40% of natural average weekly flow is generally equivalent to naturalized 90% exceedence flow. Thus, PRC criterion 1 prevents reductions to natural low flows that have exceedences of 90% or greater, and PRC criterion 2 only allows flows to be reduced to a level equivalent with 90% naturalized exceedence flows. Moderate to high PRC flows are defined by the greater of either 65% naturalized flow (criterion 3) or a flow that corresponds to a 50% increase in the naturalized return interval (criterion 4) (eg: a flow magnitude that would have occurred once every 10 years will be shifted to once every 15 years). Together, these criteria provide the mid-range flows that form a gradual bridge between minimum flows and peak flows to simulate a natural pattern of flow variability. Finally, PRC criterion 5 proposes that the maximum flow required is equivalent to 125% of bankfull flow. The integration of these five PRC criteria (Figure 2) produces a continuous weekly exceedence curve that is somewhat flattened when compared to the naturalized one, but that retains a relatively natural pattern and range of flow variability.

3.1.2 Flow datasets & PRC calculations

Six test reaches were selected for analysis. Two test reaches were defined along each of the Belly, Waterton, and St. Mary rivers in the Oldman River Basin. These included an upstream and downstream reach relative to, a) the Belly River Diversion Weir, b) the Waterton Dam, and c) the St. Mary River Dam. The upstream and downstream reaches are also referred to as upper and lower respectively and have been abbreviated throughout these discussions as UBEL and LBEL, UWAT and LWAT, and USTM and LSTM (upper and lower Belly, Waterton, and St. Mary rivers respectively). The approximate location of each test reach is indicated in Figure 4. All available actual (recorded) and naturalized (reconstructed) weekly streamflows (generally during the period from 1912 though 1995) were acquired for each test reach from Alberta Environment (2001). Descriptions of how naturalized flows were reconstructed are found in Alberta Environmental Protection (1998). The raw naturalized and actual flow data are listed in Appendix 1 and 2 respectively. The station locations and the types and periods of flow records used for each reach are summarized in Table 3. The weekly 125% bankfull flow for each test reach (Table 3) was estimated based on historic weekly flows during weeks when an instantaneous flow of 125% bankfull magnitude (Table 3) occurred at least once.

Weekly PRC flows were calculated for each of the six test reaches using the available records of naturalized flows and the five criteria outlined in Figure 1. For each individual reach, PRC calculations were generated in a Microsoft Excel (1998 version) workbook file consisting of six worksheets containing 'live' formulae to facilitate their re-use in future applications. A detailed explanation of the calculations is included in each workbook file. In summary, the PRC flow was calculated for each weekly naturalized flow in the 1912-1995 dataset using a series of logical decisions. If the exceedence of the naturalized flow was less than 90%, the lesser of naturalized flow or 125% bankfull flow was prescribed for the PRC. If both 65% of the naturalized flow and the 50% return interval-shifted flow were less than the naturalized 90% exceedence flow, the formula prescribed the lesser of naturalized 90% exceedence flow or 125% bankfull flow. Otherwise, the PRC was prescribed as the greater of 65% naturalized flow or the 50% return interval-shifted flow, to a maximum of 125% bankfull flow. The resulting weekly PRC flow datasets are presented in Appendix 3.

3.2 Evaluating PRC flows along test reaches in the Oldman River Basin

One way to evaluate PRC flows is to compare them to actual regulated flow regimes that have had known impacts on downstream riparian poplar forests. To do this, PRC flows have been generated based on historical records of reconstructed natural flows for reaches of the Belly, Waterton, and St. Mary rivers (described in Section 3.1). These flows were compared to the actual flow regimes along each reach to estimate their potential long-term effects on riparian cottonwoods.

It should be noted that although the St. Mary Dam has operated slightly longer than the Waterton Dam, the St. Mary Dam has still only influenced approximately the last 50% of the flow-record represented (since 1951). For this reason, the severity of modifications to natural flow exceedences have probably been underestimated in representations featuring the full period of record (1912-1995).

3.2.1 Suitability of PRC flows along the Belly River

Select annual weekly hydrographs and weekly three-dimensional exceedence curve surfaces comparing actual and PRC flows along upper and lower portions of the Belly River are provided in Figures 17, 18, and 19. Similar depictions of natural versus actual flows are provided in Figures 7, 8, and 9.

The regulated flow regime along the Belly River has not had strongly negative effects on downstream riparian woodlands (discussed in Section 2.3.3). However, there has been an increased incidence of chronic drought stress symptoms in forests downstream from the Belly River Diversion Weir (Reid et al. 1992). Since increased frequency and duration of natural low flows are the most likely cause, further reductions to low flows should be avoided. Otherwise, the pattern of flow regulation downstream from the BRDW appears to be adequate for sustaining downstream riparian cottonwood forests in this context.

The flow regime along the lower portion of the Belly River that would have resulted if PRC flows were implemented during the period of record (Figure 19b) differ in two main ways from the flows that were actually recorded during the same period (Figure 19a). Firstly, the PRC would permit greater reductions to extremely high flows than actually occurred. The affected peak flows have natural exceedences of less than about 5% (<1:20 year recurrence interval), and would equate with over-bank flooding. Considering their extreme magnitude and infrequency, these high flows probably exceed the basic moisture requirements for keeping established cottonwood trees healthy. Instead, as described in Section 2.2.4, extremely high flows may be necessary for driving the geomorphic processes that set the stage for episodic, widespread cottonwood seedling recruitment events. In theory, the PRC's threshold peak flow of 125% bankfull discharge (Table 4) seems a reasonable limit for high flow events because it should allow slight over-bank flooding to continue to occur at a natural frequency to preserve processes key for seedling recruitment. However, the stage relationships of bankfull and 125% bankfull discharge must be verified in the field to fully evaluate the implications of completely eliminating peak flows beyond this threshold.

The second main difference between the actual and PRC flow regime along the Belly River is that the actual flows (Figure 19a) feature greater reductions to extremely low flows (85-100% Exc.) than the PRC (Figure 19b). This difference is apparent in Figure 19c where the flow reductions (y-axis) are negative (signifying that the PRC would require an increase to actual flows). Although this difference seems subtle between these exceedence curves, comparisons of annual hydrographs show that particularly during low flow years the PRC's protection of minimum flows might be important for preventing extended periods of extremely low flow as occurred during 1977 (Figure 7 and 17). The PRC would not prevent extremely low flows but rather, would simulate the natural frequency of low flow periods. In this way, the PRC's protection of minimum flows would reduce the occurrence of chronic drought stress reported downstream from the BRDW.

Historically, there has been very minor flow modification upstream from the BRDW (Figures 7, 8), and riparian cottonwood forests in this reach are considered to be in relatively pristine condition. Implementation of PRC flows along this reach would result in the same types of flow modifications as downstream except at lesser magnitudes proportional to the naturally smaller volumes of flow (Figures 17, 18). Since the contexts of upstream and downstream forests are very similar, it is expected that their moisture requirements would be essentially the same. Therefore, PRC flows should be acceptable for sustaining riparian cottonwoods along the Belly River as a whole. However, in reducing natural flow variability, the PRC flow regime is likely to result in some degree of reduced diversity in the floodplain landscape.

3.2.2 Suitability of PRC flows along the Waterton River

Select annual weekly hydrographs and weekly three-dimensional exceedence curve surfaces comparing actual and PRC flows along upper and lower portions of the Waterton River are provided in Figures 20, 21, and 22. Similar depictions of natural versus actual flows are shown in Figures 11, 12, and 13.

The regulated flow regime generated by the Waterton Dam has had moderately negative impacts on downstream riparian forests (detailed in Section 2.3.4). Symptoms of these impacts include acute and chronic drought stress, reductions to the mature canopy, and conditions detrimental to seedling recruitment. Regime modifications associated with these impacts include inadequate flows during the growing season, depressed natural low flows, and abrupt reductions following annual peak flows.

The pattern of flow that would have resulted if the PRC was implemented along lower portions of the Waterton River from 1912 to 1995 (Figure 22b) differs in several ways from the actual regime that occurred during this period (Figure 22a). As was the case along the Belly River, the PRC accepts significant reductions to extremely high flows (Figure 22c, 1975 in Figure 20). The PRC's upper flow limit of 125% bankfull discharge equates to flows with natural exceedences of generally less than 5% (Table 4). As was the case for the Belly River, the long-term geomorphological consequences of eliminating flows beyond the 125% bankfull magnitude need to be more fully investigated. The PRC would provide peaks of slightly greater than bankfull discharge to occur at relatively natural frequencies and more gradual declines following these peak annual flows than has occurred historically (ie: 1975 in Figure 20). This modified pattern of flow should still be sufficient to recharge the riparian water table and promote the 'fringe' recruitment of cottonwood seedlings (producing narrow bands of seedlings that parallel the channel at a common stream-stage elevation) if delivered properly using appropriate daily operations.

With respect to improving the status of riparian cottonwood forests below the Waterton Dam, the most important difference between PRC and actual historic flow regimes along the Waterton River relates to natural low flows (90-100% Exc). The actual reductions made to these natural low flows (Figure 13c) are not advised by the PRC (Figure 22c). It should be remembered that the Waterton Dam has been in operation since 1964, and so has only influenced the latter 40% of the flow-record represented (1912-1995). Although a larger than average proportion of low flow years have occurred since 1964, the Waterton Dam has caused very significant reductions to already naturally low flows (Figure 13 and 1977 in Figure 11). By preventing reductions to already naturally low flows in the 90 to 100% exceedence range (Figure 22), PRC flows would have reduced acute and chronic drought stress that is presently widespread downstream from the Waterton Dam (discussed in Section 2.3.4).

The flow regime upstream from the Waterton Dam has remained relatively unaltered from its natural state (Figure 12). Flow reductions allowed by the PRC (Figure 21) would produce PRC flows similar to those downstream from the Dam (Figure 22), except that they would be proportional to the smaller size of natural flow magnitudes along the upstream reach. Because the physical context of the floodplain and the distribution of riparian forests above and below the dam are similar, the PRC flow regime is expected to be similarly suitable for sustaining cottonwoods along the Waterton River as a whole. However, PRC associated reductions to natural flow variability could result in some degree of reduced diversity in the floodplain landscape.

3.2.3 Suitability of PRC flows along the St. Mary River

Select annual weekly hydrographs and weekly three-dimensional exceedence curve surfaces comparing actual and PRC flows along upper and lower portions of the St. Mary River are provided in Figures 23, 24, and 25. Similar depictions of natural versus actual flows are shown in Figures 14, 15, and 16.

The regulated flow regime downstream from the St. Mary Dam has been associated with near collapse of the affected cottonwood population (detailed in Section 2.3.5). Symptoms include signs of acute and chronic drought stress, significant reductions in forest abundance, and the failure of seedling recruitment. Flow-regime modifications associated with these impacts include inadequate flows during the growing season, depressed natural low flows, abrupt reductions following annual peak flows, and disturbed timing of high flow events.

If the PRC had been implemented along the St. Mary River from 1912 through 1995, the resulting flow regime (Figures 24b, 25b) would differ substantially from that which actually occurred (Figures 24a, 25a). In general, the PRC would have permitted greater reductions to extremely high peak flows, less severe reductions to moderate flows, and no reductions to extremely low flows (Figures 24c, 25c). Additionally, since the PRC is based on natural flow exceedences, it would have incorporated a more natural seasonal pattern of high and low flows than actually occurred (Figures 14, 23).

The elimination of flows greater than 125% bankfull discharge affects peak flows with exceedences of less than about 5% (Table 4). These extremely high flows probably surpass the magnitude necessary for recharging the riparian water table and creating nursery sites for cottonwood seedling establishment. However, less direct effects of extreme peak flows may involve the geomorphic complexity of the floodplain landscape by influencing rates of channel migration. The long-term consequences of eliminating flows beyond 125% bankfull magnitude need to be more fully investigated.

The PRC would allow high flows that were reduced to 125% bankfull to occur at relatively natural frequencies and would provide more gradual declines following these peak annual flows than has occurred historically (ie: 1975 in Figure 23). This pattern of flow should be sufficient to recharge the riparian water table and provide adequate flow to promote seedling recruitment if delivered properly. While high to moderate flows are important for seedling establishment, the subsequent rate of flow decline is also essential to ensure seedling survival. Recent efforts to produce gradual rates of decline following peak flows by careful management of daily operations have been successful in initially promoting seedling establishment along the lower portion of the St. Mary River (Rood and Mahoney 2000).

Compared with the actual flow regimes recorded along the upper and lower portions of the St. Mary River, the flow regime created by the PRC would be considerably more favorable to sustaining healthy riparian cottonwood forests. In particular, flow reductions permitted by the PRC would be less severe, and their timing and frequency across flow magnitudes would follow a more natural pattern (Figures 14, 23).

3.2.4 Overall suitability of PRC flows

The comparative evaluation of PRC flows as they relate to naturalized and actual flow regimes along the six test reaches suggests that PRC flows would help maintain riparian cottonwood forests along these reaches. Compared with the actual flow regime, PRC flows are expected to provide more favorable conditions along the three downstream reaches, and may also be acceptable along the three upstream reaches.

The impact of regulated flow regimes on riparian cottonwoods along the downstream reaches of the Belly, Waterton, and St. Mary rivers have been relatively benign, moderately negative, and severely negative respectively. In all three cases, reductions to low flows have been associated with drought stress and declines in cottonwood forests. PRC flows address this situation by preventing further reductions below natural low flows. This flow adjustment should correct the symptoms of drought stress observed along the lower part of the Belly River. The PRC otherwise resembles the actual regulated flow regime along this reach. Along the other two downstream reaches (of the Waterton and St. Mary rivers), reductions affecting medium and larger flows have also been implicated with negative impacts on riparian cottonwoods. The PRC would improve their situation by moderating those reductions. The combination of protected low flows and moderated reductions to larger flows along the Waterton test reach would be expected to remedy its declining condition. Along the most severely impacted reach (the lower part of the St. Mary River), natural flow variability has been significantly altered. The PRC approach should correct this problem since it is based on natural flow variability. Thus, combined with protecting low flows and moderating reductions to larger flows, the more natural pattern and timing of flow variability proposed by the PRC should prevent further deterioration and might even assist the rehabilitation of riparian forests along the lower reach of the St. Mary River.

The part of the PRC that cannot be adequately evaluated based on comparisons with the implemented flow regimes along the test reaches is the reduction of peak flows that exceed 125% bankfull. It is not possible to infer the effects of such a change because none of the flow regimes along the test reaches have been modified in this way.

3.3 Evaluating the PRC Criteria

3.3.1 Relative contribution of each PRC criterion

Results of comparisons between PRC flows and actual flow regimes along the selected test reaches (reviewed in Section 3.2) have generally supported the utility of the PRC in sustaining riparian cottonwood populations. A more detailed validation of the PRC is possible through the individual assessment of each of the five PRC criteria (Figure 1) whose exceedence curves (Figure 2b) are the basis of the final PRC. Each individual criterion influences a particular range of flows in the final PRC (Figure 26, Table 5). To evaluate each criterion, the flows in the affected exceedence range have been compared to the corresponding regulated flows implemented along the various test reaches. Based on these comparisons, flows proposed by each PRC criterion have been assessed relative to the affects that they are likely to have on downstream cottonwood health as suggested by trends reported along the various test reaches. A summary of these assessments is presented in Table 6.

3.3.2 PRC criterion 1: Naturalized flow

PRC criterion 1 prevents reductions to natural low flows that have exceedences of between 90 and 100% (Figure 26, Table 5). Natural 90% exceedence flows generally qualify as minimum flows since, they are met or exceeded (on average) in 90% of years. The averaged magnitudes of reductions that have actually been made at each test reach within this category of minimum flows are summarized in the shaded portions of Figure 27a and b. The PRC proposes no reductions to flows with natural exceedences in this range. Thus, the change to weekly flows (y-axis) would be 0% (dashed line) for exceedences between 90 and 100%.

The upper reach of the Waterton River is unregulated, having no significant alterations to its flows including those in the range from 90 to 100% naturalized exceedence (Figure 27b). Thus, its flows meet the requirements for PRC criterion 1 (Table 6). In contrast, regulation along the other five test reaches has caused reductions of between 20 and 95% to already low flows in the range from 90 to 100% natural exceedence (Figure 27b). The three downstream test reaches have been particularly severely impacted by greater than 70% reductions to these low flows. This trend corresponds with the frequencies of acute drought stress reported along the lower reaches as compared to the less-regulated upstream reaches, and suggests that this range of reduction to low flows is not acceptable in the PRC.

The magnitudes of flow reductions affecting natural 90 to 100% exceedence flows are generally comparable along the upper St. Mary and upper Belly rivers, ranging from about 20 to 40% reduction. However, signs of drought stress have been reported for cottonwoods along the upper St. Mary River and not along the upper Belly River. This disparity appears to be related to differences in flow reductions across the rest of the exceedence range (exceedences of 0 to < 90%), since overall weekly flow reductions along the upper St. Mary have been more severe than along the upper Belly (averaging 25% versus 10% respectively, un-shaded portion of Figure 27a). This trend suggests that while the maintenance of low flows is critical to cottonwood health, moderate and higher flows are also important. Additionally, the size and geomorphic context of the Belly River is quite different from that of the St. Mary River (Table 1) and these differences may affect the ultimate resilience of each system to similar levels of flow reductions.

The moderate rate of 20 to 40% flow reduction affecting low flows along the upper Belly River combined with lesser reductions (about 10%) to flows with exceedences less than 90%, are associated with no discernable drought stress in the affected riparian forests. However, along the upper St. Mary River, the same moderate rate of 20 to 40% flow reduction extended over the full range of flow exceedences has caused symptoms of drought stress. Considering that criterion 3 of the PRC allows marginally greater reductions (35%) than those experienced along the upper St. Mary River (30%) for moderate flows with 50 to 70% exceedence, reductions of more than 30% to low flows should be avoided to prevent reproducing the drought stress observed along the upper St. Mary River.

Criterion 1 of the PRC is conservative, permitting 0% reduction to flows between 90 and 100% natural exceedence. Based on the available evidence, reductions of up to about 30% may be acceptable if flows are conserved across the rest of the exceedence range. Conversely, the complete protection of these low flows would probably compensate for reductions made to moderate and higher flows.

3.3.3 PRC criterion 2: Naturalized 90% exceedence flow

PRC criterion 2 allows flows to be reduced to a minimum of naturalized 90% exceedence flow. This criterion generally affects flows with naturalized exceedences between 90 and about 60% (Figure 26, Table 5). A comparison of regulated (actual) weekly flows and natural 90% exceedence flows is summarized for each test reach in Figure 28. The shaded portions in this figure encompass the exceedence range that is generally affected by PRC criterion 2 (natural 90 to 60% exceedence). Flows greater than the 90% exceedence flow are recorded as positive values and flows less than the 90% exceedence flow are negative.

The six test reaches show considerable variation relative to 90% exceedence flow levels (Figure 28b). On average, 60 to 90% exceedence flows along the upstream reaches of the Waterton and Belly rivers have remained greater than natural 90% exceedence flows. The same group of flows along the upper portion of the St. Mary River has averaged about 15% less than the 90% exceedence flow level. Flows along the lower reaches of the Belly and the Waterton rivers have had reductions between 50 and 80% relative to natural 90% exceedence flow levels, and flows along the lower reach of the St. Mary River average even less, showing 90% reductions below natural 90% exceedence flow levels. The magnitudes of reductions below natural 90% exceedence flow levels correspond closely with the increasingly poor state of riparian forest health across the six test reaches (Table 2).

Declining riparian cottonwood health along the lower test reaches suggests that the 50% or greater reductions below natural 90% exceedence flows (in the range from 60 to 90% exceedence) that were recorded along the lower reaches are not appropriate in the PRC. Similar to the logic developed in evaluating PRC criterion 1, a 'safe' level of reduction for flows affected by criterion 2 is likely between that recorded along the upper part of the Belly River (where forests are healthy) and the upper St. Mary River (where forests are showing symptoms of drought stress). The PRC criterion 1 proposal of 0% reduction to 90% exceedence flows (dashed line in Figure 28b) falls within this range and is thus justified. Reductions of greater than 10% are discouraged to avoid duplicating the stressed condition of riparian cottonwoods along the upper reach of the St. Mary River.

3.3.4 PRC criterion 3: 65% of naturalized flow

PRC criterion 3 proposes a 35% reduction to flows with natural exceedences between 50 and 70% (Figure 26, Table 5). The average magnitude of reductions that have actually been made at each test reach within this category of flows are summarized in the shaded portions of Figure 29 (the 35% reduction permitted by criterion 3 is indicated by the dashed line). All three of the upper test reaches have averaged less than this 35% reduction (Figure 29b). Flow reductions along the upper St. Mary closely parallel the 35% value. Flow reductions recorded along the lower Belly and lower Waterton reaches range between 40 and 80%, and along the lower St. Mary reductions are even more severe, ranging from 80 to 90%.

As was the case for PRC criterion 1 and 2, flow modifications recorded along the upper reach of the St. Mary River probably coincide with the threshold of reduced flows that can still maintain healthy cottonwoods. The 35% flow reduction permitted by PRC criterion 3 is slightly more severe than the average 30% reduction that has occurred along the upper St. Mary reach. Combined with the conservative approaches of criterion 1 and 2, this more moderate reduction may still be reasonable in the PRC. However, reductions greater than 40% are expected to be detrimental as evidenced along the lower reaches of the Waterton River and the St. Mary River in particular.

Although setting an appropriate limit to the level of flow reduction permitted by PRC criterion 3 is important for maintaining the health of riparian cottonwoods, the value for criterion 3 should also provide a gradual 'bridge' between the exceedence curves of criterion 2 and 4 (Figure 2b). This will ensure that the natural pattern of flow variability intrinsic to the natural functioning of the system will also be preserved. In about one third of growing season weeks, criterion 3 does not register in the PRC (Figure 26). In these instances, the intended gradual transition between criterion 2 and 4 is absent. The adjustment of criterion 3 from 65% to 70% naturalized flow may correct this anomaly and also lessen flow reductions that would otherwise be equivalent to the marginal flow conditions along the upper St. Mary River.

3.3.5 PRC criterion 4: 50% return interval-shifted naturalized flow

PRC criterion 4 would allow flow reductions equivalent to 50% return interval (RI) increases. This criterion defines the broad portion of the PRC between about 5 and 60% naturalized exceedence (Figure 26), and so affects mainly average and greater weekly streamflows. The actual RI-shifts that were recorded during a selection of flow regulated years along each test reach are summarized in Figure 30. Here, the range of influence of criterion 4 is shaded and the threshold RI-shift of 50% is indicated by a dashed line.

RI-shifts have been consistently greater along the lower reach as compared to the upper reach of each river. The RI-shifts recorded along the lower St. Mary have been the most severe, averaging greater than 200% (Figure 30b). Shifts along the lower Belly, lower Waterton, and upper St. Mary have been moderately severe, averaging between 100 and 200%. RI-shifts along the upper Waterton and upper Belly have been much smaller, averaging less than 50%. Thus, increasing severity of RI-shifts correlates with decreasing riparian forest health along the test reaches (Table 2).

RI-shifts are not solely responsible for trends in decreasing riparian forest health. Among the six test reaches, declines in cottonwood abundance and general health have been most closely associated with reductions to low flows. A test reach where low flows remain completely unchanged while moderate and larger flows are altered is not available to isolate the effects of modifications to greater flows. However, lower flows (naturalized 60 to 100% exceedence) along the upper reaches of the Waterton, Belly, and St. Mary rivers have been less altered than along the lower reaches (Figures 27, 28). In particular, the slight reductions that have been made to these low flows along the upper Belly and upper St. Mary reaches are similar, making these reaches good candidates for evaluating the effects of changes made to larger flow events.

Riparian cottonwoods along the upper reach of the Belly River are in reasonably good health, while those along the upper reach of the St. Mary River have shown signs of stress and increased seedling mortality (Reid et al. 1992). Considering that the slight reductions to low flows along both reaches have been relatively consistent, this difference in cottonwood health and reproductive success could be related to differences in modifications to larger flows. The large RI-shifts of 100 to 300% relative to naturalized return intervals that have been recorded along the upper St. Mary River suggest a threshold of tolerable reductions to larger flows while the shifts of less than 50% recorded for the upper Belly River probably represent a more acceptable range (Figure 30). Since the 50% RI-shift permitted by the PRC (dashed line in Figure 30) is slightly greater than shifts recorded for the upper Belly River, this value is likely acceptable in the overall PRC. Due to the scarcity of controls among the test reaches, it is not possible to determine with certainty what level of flow reductions beyond the 50% RI-shift threshold would be safe for maintaining riparian cottonwoods.

3.3.6 PRC criterion 5: 125% bankfull flow

PRC criterion 5 would permit high flows to be limited to the weekly equivalent of instantaneous 125% bankfull discharge (Figure 26, Table 5). Although bankfull discharge can be defined in may ways (Williams 1978), instantaneous bankfull discharge is defined here as the flow magnitude required to completely fill the active channel. This value varies across reaches as it relates to the physical dimensions of the cross-section of each channel. Since the PRC is a weekly exceedence curve, a weekly equivalent for 125% instantaneous was required in criterion 5. The weekly time-step used in the PRC is not compatible with the naturally shorter duration of greater than bankfull flows which often last only one to three days at most. This complicates the selection of an appropriate weekly equivalent for instantaneous 125% bankfull flows. For the purposes of this report, weekly 125% bankfull flow values have been estimated based on historic weekly flows during weeks when instantaneous 125% bankfull magnitude has occurred at least once. The instantaneous 125% bankfull value and its weekly equivalent, used in calculating the PRC, are presented in Table 3 for each test reach. Based on these weekly estimates of 125% bankfull flow, PRC criterion 5 would affect flows with naturalized exceedences of less than 10% (Table 4) during weeks of peak annual streamflow, usually Julian weeks 21 through 27 (Figure 26), that correspond with the last week of May through the first week of July.

Natural peak flows of 125% bankfull magnitude or greater occur infrequently (< 1 in 10 year recurrence during peak flow weeks). Considering the relatively short period of available flow-record (< 50 years), the evaluation of this value based on the test reaches is problematic. Historic reductions to natural peak flows greater than 125% bankfull have been minimal along the test reaches (Figure 31). Since regulation has generally not reduced these peak flows below the 125% bankfull level permitted by PRC criterion 5 (indicated by the dashed line in Figure 31), test cases are not available to adequately evaluate the actual effects of such a reduction to high flows (Table 6). Even along the most severely impacted reach (the lower St. Mary River), peak flows have not been reduced to this extent. Since quantitative examples from implemented flow regimes are inadequate to evaluate 125% bankfull flow as a cut-off for peak flows, a more qualitative approach has been used to assess the magnitude of peak flows necessary for preserving functional riparian forests.

The importance of peak flows to cottonwoods (as detailed in Section 2.2.4) is mainly related to 1) riparian water-table recharge and 2) the geomorphic processes that prepare nursery sites for cottonwood seedling establishment. As such, long-term reductions to these peak flows may cause drought stress to trees in marginal areas and to seedlings or saplings that lack well-established root systems. Geomorphologically, reductions to peak flows may also interrupt natural patterns of nursery site formation, resulting in less frequent and / or less suitable opportunities for successful seedling establishment. Since channel and floodplain topography and the elevational distribution and composition of riparian forests are highly variable, the choice of a maximum peak flow could have complex and varied effects on riparian and aquatic ecosystems. Thus, the implications of 125% bankfull as a maximum flow need to be further investigated. It is strongly advised that the physical parameters defining cottonwood requirements for high flows be investigated along each test reach to better define acceptable reductions for peak flows in each case.

3.3.7 Summary of evaluation of PRC criteria

PRC criterion 1 protects flows below the naturalized 90% exceedence level. Occasional, slight reductions (<30%) to flows in this exceedence range alone might not be seriously harmful. However, combined with moderate reductions to larger flows, there is an increasing likelihood of inducing chronic drought stress in downstream forests.

PRC criterion 2 would prevent reductions below naturalized 90% exceedence flow. Similar to the case for criterion 1, occasional, slight reductions below the 90% exceedence threshold may not have serious consequences. However, reductions of greater than 10% may not be acceptable. Considering that 10% of a naturalized 90% exceedence flow represents a relatively insignificant volume from a management perspective, the risk associated with adjusting criterion 2 is not merited.

The assessment of PRC criterion 3 suggests that while the 35% reduction might be adjusted to 40% without harming riparian forests, such a reduction would prevent PRC criterion 3 from providing a gradual transition between the exceedence curves of criteria 2 and 4. Thus, the 35% flow reduction allowed by criterion 3 should only be altered in concert with a similar adjustment in the exceedence curve for criterion 4.

PRC criterion 4 permits flow reductions equivalent to 50% return interval increases. Based on the trends along the test reaches, this value seems generally acceptable. Due to the variability among the reaches, it is not clear if a further reduction would still be adequate for maintaining healthy downstream forests.

PRC criterion 5 would permit peak flows to be limited to 125% bankfull. Considering that actual reductions to flows beyond this magnitude have been relatively minor along the test reaches, the appropriateness of the 125% bankfull value as a maximum in the PRC cannot be verified using these test cases. This criterion is the only part of the PRC that is defined by an absolute value that is calculated without reference to the historic flow record. The 125% bankfull value is recommended only as an initial approximation that requires further consideration on a reach-specific basis.

The individual assessments of the five PRC criteria (summarized in Table 6) have generally supported their use in the PRC approach to meeting the flow requirements of riparian cottonwoods in the SSRB. Trends observed along the test reaches suggest that minor revisions could safely be made to several of the criteria used in calculating the overall PRC.

3.4 Applicability of PRC flows for other systems

3.4.1 Red Deer River Basin

The Red Deer River is the most northern and least regulated river in the South Saskatchewan River Basin (Figure 4). There are approximately twelve small reservoirs on its tributaries. The only major regulatory structure is the Dickson Dam which is located on the main-stem of the Red Deer River upstream from the City of Red Deer. The Dickson is a low capacity dam that was built for flood control and hydropower generation and has been in operation since 1983.

Two species of riparian cottonwoods occur in the Red Deer River Basin, the plains cottonwood (***Populus deltoides***) and the balsam poplar (*P. balsamifera*). The two species hybridize where their ranges overlap in the Drumheller area (Figure 5). The differences in the ranges of the two species appear related to differences in their regenerative strategies and temperature tolerances. Although both species are capable of producing seedlings, *P. balsamifera* is more able to reproduce clonally by suckering (Gom & Rood 1999). This clonal ability may be increasingly adaptive to the north and west, where conditions are less conducive for seedling establishment due to increasing stream gradients and coarser floodplain substrates.

The riparian forests along the Red Deer River tend to be dominated by mature and aging cottonwoods that were established as seedlings between the 1890s and 1930s [1] (Marken 1993). This period of widespread recruitment of seedlings was associated with a series of large floods that were of approximately 1 in 100 year magnitude (Cordes et al. 1997). A series of more moderate floods (greater than 1 in 10 year magnitude) occurred in the 1950's. Seedling recruitment was stimulated by these flows but was less widespread and occurred lower on the streambanks (Cordes et al. 1997). Comparisons of aerial photographs indicate that there has been little change to overall riparian forest abundance along the Red Deer River since the 1950's (Table 1).

Since 1950, there have been no large floods and negligible channel migration (Marken 1993). Subsequently, there have been fewer opportunities for cottonwood seedling establishment. Terraces of the lower Red Deer River floodplain are now well above the 1 in 100 year flood level. Thus, the majority of the large cottonwood stands that were established there over 50 years ago are not likely to be replaced unless large floods, of greater than 1 in 50 year magnitude, occur again (Cordes et al. 1997). Currently the establishment of seedlings is limited to a narrow zone of barren, moistened substrates closely paralleling the active channel. This pattern of 'fringe' replenishment has become the dominant form of regeneration for cottonwoods along the Red Deer River.

After the Dickson Dam became operational in 1983, the mean monthly discharge during the spring and summer has been lowered considerably (Marken 1993). This trend may be associated with increases in water demand and possibly reduced precipitation. The timing of the flood peak has also been shifted from June to July (Marken 1993). By attenuating flood flows and reducing summer flows, the Dickson Dam may be exacerbating an already declining situation for cottonwoods along the Red Deer River, all but eliminating the already rare opportunities for seedling establishment.

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[1] Marken (1993) reported that catastrophic floods occurred on the lower Red Deer River in 1905 and 1915 and may also have occurred in 1867 and the late 1870s, when record high floods also occurred on the Bow River. This would have resulted in four floods of 1 in 100 year magnitude, during a span of only 45 years. Additionally, large floods occurred in 1923, 1928, 1929, and 1932.

In addition to streamflow modifications, there are a variety of other activities that impact cottonwoods along the Red Deer River. In particular, livestock grazing has had moderate to severe impacts (Marken 1993), as browsing and trampling tends to remove seedlings and degrade nursery sites. Additionally, expansion of settlements and other land-uses continues to encroach on riparian areas, removing forests and increasing the demand for flood protection.

Cordes et al. (1997) have made the following flow recommendations to help remedy the declining situation for cottonwoods along the Red Deer River:

1) Preserve the magnitude, timing and duration of greater than 1 in 5 year flood flows and attenuate large floods to no lower than 1 in 20 year discharge (this is the minimum flood flow that is required for maintaining recent levels of regeneration)
2) Do not modify very high floods of greater than 1 in 50 year magnitude (these flows are necessary for widespread regeneration)
3) Following greater than 1 in 10 year floods, leave flows unaltered for the rest of that year and the next, to maintain moisture levels for seedling survival.
4) Always maintain minimum flows during the ice-free period to prevent stress.

In his critique of Cordes et al. (1997), Rood (1997) re-emphasizes the importance of 1 in 10 to 1 in 100 year flood flows for floodplain processes and cottonwood seedling recruitment along the Red Deer River. Additionally, Rood (1997) suggests that a gradual rate of flow decline following the peak of flood flows may be as or more important than the magnitude of the flood peak. A flow decline rate of 2.5 cm per day should allow seedling root growth to keep pace with the receding water table (Mahoney & Rood 1998), thus improving seedling survival by reducing the incidence of drought stress. Rood (1997) also suggests that clonal propagation may provide a natural buffer to compensate for periods that are less conducive for seedling-based regeneration.

The PRC approach toward designing IFN for riparian cottonwood forests seems appropriate for managing cottonwood forests along the Red Deer River. The PRC has provisions for protecting minimum flows, natural seasonal flow variability, and some degree of flooding. Probably the most important issue for cottonwoods along the Red Deer River is the inadequate level of seedling replenishment. Successful seedling recruitment generally requires high springtime flows to prepare nursery sites followed by gradual flow recessions to promote seedling root growth and prevent drought stress. The PRC should provide sufficient flows for daily operations to be successful in providing these types of conditions at a natural frequency.

In the case of the Red Deer River, reductions to peak flows have been associated with insufficient seedling replenishment. Thus, it would be essential to verify the appropriateness of the 125% bankfull limit to peak flows. The 125% bankfull values for the test reaches are generally equivalent to a 5% weekly exceedence flow (Table 4) which equates with the 1 in 20 year discharge advocated by Cordes (1997).

3.4.2 Bow River Basin

The Bow River Basin (Figure 4) is probably the most regulated river system in Alberta. Above the City of Calgary, there are more than ten hydroelectric dams operating on the upper tributaries of the Bow River. Of these, major dams on the main-stem of the Bow River include the Kananaskis Dam (operating since 1914), Horseshoe Dam (1911), Ghost Dam (1929) and Bearspaw Dam (1954). These dams are operated to meet peak power demands. They tend to moderate natural high and low flows, but do not divert water away from the river. Progressing downstream, major flow diversions are made via the Western Irrigation District Diversion Weir (1912) at Calgary, the Carseland Diversion Weir (1918) for the Bow River Irrigation District, and the Eastern Irrigation District Diversion at the Bassano Dam (1914). These diversions have the capacity to substantially dewater the river downstream (Rood et al. 1999, Rood & Bradley 1993).

Two and possibly three species of riparian cottonwoods occur on the floodplains along the Bow River and its tributaries (Figure 5). *Populus balsamifera* is especially common, *P. deltoides* is common downstream from the Bassano Dam, and P. *angustifolia* (narrowleaf cottonwood) has been reported to occur along the Highwood River (Michalsky et al. 1991). Abundant mature cottonwood groves occur in the river valleys across the region, and the existing mature trees appear to be generally healthy since there is little evidence of branch or crown die-back, and overall forest abundance has not changed appreciably in over 100 years (Table 1). Thus, dams and diversions upstream have probably not produced appreciable drought stress in recent years (Rood & Bradley 1993). However, a deficiency of younger trees suggests that rates of regeneration are insufficient to maintain the present extent of these forests.

The existing mature forests along the Bow river were probably established as seedlings during a few major recruitment events (Cordes 1991, Rood et al. 1999, Rood & Bradley 1993). These periods of recruitment correlate strongly to periods with high flood flows (Cordes 1991, Rood et al. 1999). Peaks of recruitment tend to correspond with flows greater than 600 m^3/s (approximately 1.5 m above base stage) at Calgary for forests upstream from the Highwood River inflow, and with flows greater than 1000 m^3/s (approximately 2 m above base stage) for forests downstream from the Highwood (Rood et al. 1999). Flows of these magnitudes occurred in 1915, 1916, 1923, 1929 and 1932, and probably led to widespread recruitment between 1915 and 1935 (Rood et al. 1999). Similarly, the flood flows that occurred between 1948 and 1953 probably contributed to moderate levels of establishment between 1948 and 1955 (Rood et al. 1999). Since then, flows have become more stabilized due to regulation and drier climatic conditions (Rood & Bradley 1993), and disproportionately fewer trees have been recruited (Cordes 1991, Rood et al. 1999). Some recruitment did occur after moderate flood flows along some reaches in 1990 and 1995 (Rood et al. 1999).

In addition to flood magnitude, other flow conditions are important for creating recruitment events. Flood flows over 1000 m^3/s occurred in 1963 and 1969, but did not lead to widespread recruitment (Rood et al. 1999). Although the flow magnitude was high enough, the timing and pattern of the flood flows were not conducive for seedling recruitment. The flood flows occurred at the beginning of July, toward the end of the period that seeds are available to germinate, and the flows declined rapidly after the peak, probably causing drought stress to any newly sprouted seedlings. Even when the magnitude and pattern of flood flows are suitable, such as occurred in 1967, recruitment may still be limited by flow conditions during the next several years. Flood flows in 1969 surpassed those in 1967, probably causing seedlings established in 1967 to be scoured away or buried by sediment (Rood et al. 1999).

If the deficient rate of recruitment that occurred between 1960 and 1990 were to continue, it might be expected that the area of cottonwood forest would gradually diminish to zero in about 100 to 150 years (Cordes 1991). Asexual reproduction is becoming the dominant form of regeneration, however declines in forest abundance and genetic diversity are likely to continue unless seedling replenishment is restored (Rood & Bradley 1993). Impacts associated with grazing by livestock, harvesting by beaver, and disturbances by humans are also becoming increasingly severe and need to be reduced to improve long-term forest survival.

Downstream from the inflow of the relatively free-flowing Highwood River, there is a more continuous range of tree sizes suggesting that ongoing recruitment has been more successful there (Rood et al. 1999, Rood & Bradley 1993). Restoration of seedling recruitment along the Bow River probably requires the implementation of high flows with more natural magnitude, timing and pattern. However, extensive urban and industrial developments in the floodplain of the Bow River within Calgary prohibits re-introduction of major over-bank flooding. Minor changes to upstream dam operation might encourage some channel migration, bar formation and subsequent cottonwood seedling establishment (Rood & Bradley 1993).

Implementation of the PRC along the Bow River would return a more natural pattern of variability and timing to streamflows. Re-establishing these flow dynamics to the Bow River would help to restore interrupted natural processes. In particular, nursery sites and enhanced seedling recruitment would result from increased bar formation and reduced encroachment of upland species. Additionally, increases to flow variability would be accompanied by increases in forest variability and diversity, improving the resiliency of the entire floodplain ecosystem.

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Table 1. Assessments of riparian forest abundances along various tributaries of the SSRB in the 1880's, 1950's, 1980's, and late 1990's using historic surveys and aerial photographs. (reach equivalents in this study: SM1 = upper St. Mary River, SM2 = lower St. Mary River, BL1 = upper Belly River, BL2 = lower Belly River, W1 = lower Waterton River)

		------------1980's------------			Riparian Poplar Density:				General
River:	**Reach:**	**Length (km)**	**Floodplain Width (m)**	**Channel Type**	**1880's**	**1950's**	**1980's**	**1997-99**	**Change 1880-1999**
St. Mary	SM1	25.4	300-700	FM	3 to 5		4	4	
	SM2	115.51	200-(1000)	CM	2		1	1	-
Belly	BL1	28.82	300-500	FM	3 to 5		3	3	-
	BL2	48.81	500-1200	FM	2		5	5	+
(below inflow	BL3	37.59	1000-1500	FM-BR	3 to 5		4	4	
of Waterton R.)	BL4	34.74	700-1500	FM	3 to 5		3	3	-
Waterton	W1	75.31	500-700	FM	3 to 5		3	3	-
Oldman	OM1	17.26	200-500	FM	3 to 5	2	2	2	-
	OM2	98.82	1500-1700	BR-FM	3 to 5	5	5	5	+
	OM3	21.28	200-1000	ST	3 to 5	2	2	2	-
	OM4	61.93	500-2000	FM-CM	3 to 5	4	4	4	
	OM5	78.64	300-2000	CM-FM	2	2	2	2 to 3	
	OM6	62.08	300-700	ST-CM	2	1	1	1	-
S. Sask.	S1	197.2	200-3000	ST-CM-FM	2	2	2	2	
	S2	35.95	200	ST		1	1	1	
	S3	54.89	200-750	ST-CM		1	2	1 to 2	+
Milk	M1	58.93	400	FM-CM	1		1	1	
	M2	23.1	undefined	FM	1		1	1	
	M3	39.74	50-500	CM	1		1	1	
	M4	26.96	200-400	CM	2		2	2	
	M5	38.19	up to 1000	FM	1		1	1	
	M6	31	500-750	CM-FM	2		2	2	
	M7	54.4	500-750	CM-FM	3 to 5		3	3	-
Red Deer	R1	22.86	200-300	CM		3	3	2	-
	R2	32.06	300-400	CM		2	2	2	
	R3	32.13	200-400	CM-ST	1	3	3	3	+
	R4	39.98	100	CM-ST	2	2	2	2	
	R5	16.48	300-500	CM	2	3	3	3	+
	R6	78.23	500	CM	3 to 5	4	4	4	
	R7	37.14	200-300	CM-ST	1	3	3	3 to 4	+
	R8	51.33	500-1300	CM-FM	2	3	4	3 to 4	+
	R9	18.45	300-500	ST-CM		3	3	3	
	R10	37.99	1000-1500	FM-BR		3	3	3 to 4	
Rosebud	RB1				3 to 5		2	2	-
Highwood	H1	9.92	100-500	ST	1		3	2 to 3	+
	H2	17.5	500-1000	FM-BR	1		2	2 to 3	+
	H3	41.76	100-500	FM	1		2	1 to 2	
Sheep	SH1	25.93	200-700	FM	1		4	3 to 4	+
Bow	B1	42.58	300-1500	FM-CM	3 to 5	3	3	3	-
	B2	38.86	500-1500	FM-BR	3 to 5	4	4	4	
	B3	48.14	500-2500	FM-BR	3 to 5	4	5	5	
	B4	36.26	500-1000	FM	3 to 5	3	3	3	-
	B5	60.38	200-500	ST	1	2	2	2	+
	B6	55.79	200-500	ST	1	1	1	1	
	B7	41.39	200-500	ST	1	1	1	1	
	B8	23.22	200-500	ST	2	2	2	2	

(1880-1980 content adapted from Bradley et al. 1991)

Channel Type categories:

FM = freely meandering
ST = straight
CM = confined meandering
BR = braided

Density categories:

1 = none / negligable
2 = sparse
3 = moderate
4 = dense
5 = very dense

Table 2. a) Documented changes to cottonwood abundances in the Oldman River Basin from the 1950's to the 1980's, along reaches upstream (upper) and downstream (lower) from the Belly River Diversion Weir (operational since 1935), Waterton River Dam (1964), and St. Mary River Dam (1951). The standard error for lineal measures is approximately < ± 5% and for area measures is about ± 20% (boxed values indicate highly significant changes). b) Summary of magnitude of changes in cottonwood abundance using ranked categories (>10% = +2, 10 to 5% = +1, 5 to -5% = 0, -5 to -10 = -1, -10 to -20 = -2, <-20% = -3).

a)

Percent change in the abundance of cottonwoods along:

	non-regulated reaches			regulated reaches		
	UBEL	UWAT	USTM	LBEL	LWAT	LSTM
Rood & Heinze-Milne 1989						
- 2D area (1961 to 1981)	-4.6	-6.1	-4.7	-0.1	-22.9	-47.8
Reid et al. 1992						
- lineal distance (1951-1985)	-7.4	-5.8	-7.2	+0.4	-9.0	-73.7
- lineal distance (1961-1981)	-4.5	-8.0	-7.1	-0.9	-20.4	-45.4
- 2D area (1951 to 1990)	-13.1	+4.7	-4.8	+21.2	+2.6	-40.0
Rood et al. 1995						
- 2D area (1951 to 1985)	-9.1	+1.9	-0.5	+52.2	+3.5	-61
- lineal distance (1951 to 1985)					-9.0	-68

b)

Ranked change in abundance:

	UBEL	UWAT	USTM	LBEL	LWAT	LSTM
lineal distance:	-1	-1	-1	0	-2	-3
2D area:	-1	0	-1	+2	-1	-3
absolute value of total:	2	1	2	2	3	6
extent of change:	moderate	slight	moderate	moderate	severe	extremely severe

Abbreviations: upper Belly River = UBEL, lower Belly River = LBEL, upper Waterton River = UWAT, lower Waterton River = LWAT, upper St. Mary River = USTM, lower St. Mary River = LSTM.

Table 3. Weekly and bankfull flows used to calculate the PRC along test reaches in the Oldman River Basin. (* indicates that flows for several weeks of that year are not available)

reach	station	location	weekly flow record available		instantaneous 125% Bankfull (m^3/s)	weekly 125% Bankfull (m^3/s)
			natural (estimate)	actual (recorded)		
UBEL	05AD005	Mountain View	1912-95	1912-95		50
LBEL	05AD002	Standoff	1912-95	1912-31*, 49-85*	100	65
	05AD041	Glenwood		1986*-95		
UWAT	05AD003	Waterton Park	1912-95	1912-31*, 48-95	180	117
LWAT	05AD008	Standoff	1912-95	1916-31*, 35-66	205	175
	05AD028	Glenwood		1965-95		
USTM	05AE027	US / Canada border	1912-95	1912-95		140
LSTM	05AE006	Lethbridge	1912-95	1912-95	200	180

Abbreviations: upper Belly River = UBEL, lower Belly River = LBEL, upper Waterton River = UWAT, lower Waterton River = LWAT, upper St. Mary River = USTM, lower St. Mary River = LSTM

Table 4. Average naturalized flow exceedences of 125% bankfull flow for each test reach during peak flow weeks (Julian weeks 21-27).

Test Reach:	Weekly 125% Bankfull Flow (m^3/s)	Average Naturalized Weekly Exceedence of 125% Bankfull Flow
UBEL	50	6.4 %
LBEL	65	2.8 %
UWAT	117	7.2 %
LWAT	175	4.0 %
USTM	140	6.4 %
LSTM	180	2.6 %

Abbreviations: upper Belly River = UBEL, lower Belly River = LBEL, upper Waterton River = UWAT, lower Waterton River = LWAT, upper St. Mary River = USTM, lower St. Mary River = LSTM

Table 5. The ranges of flow affected by each PRC criterion.

PRC Criteria:	range of affected naturalized flow exceedence:
1) Naturalized Flow	100 - 90% Exc.
2) Naturalized 90% Exceedence Flow	90 - 60% Exc.
3) 65% of Naturalized Flow	50 - 70% Exc.
4) 50% RI-shifted Naturalized Flow	5 - 60% Exc.
5) 125% Bankfull Flow	0 - 10% Exc. (during weeks 21 - 27)

Table 6. Summary of how recorded flows along each test reach compare to flows required by each individual PRC criterion (++ exceeds PRC, + meets PRC , - fails PRC, and - - severely fails PRC).

(PRC Criteria)	UBEL	UWAT	USTM	LBEL	LWAT	LSTM
1. Nat.Flow	-	+	-	- -	- -	- -
2. Nat.90%Exc.Flow	+	+ +	-	- -	- -	- -
3. 65%Nat.Flow	+ +	+ +	+	-	-	- -
4. 50%RI-shifted	+	+ +	-	-	-	- -
5. 125% Bankfull	+ +	+ +	++	++	++	++
overall ranking :	2	1	3	4	4	5
change in forest abundance (Table 2)	moderate	slight	moderate	moderate	severe	extremely severe

Abbreviations: upper Belly River = UBEL, lower Belly River = LBEL, upper Waterton River = UWAT, lower Waterton River = LWAT, upper St. Mary River = USTM, lower St. Mary River = LSTM

Figure 1. Flow-chart of criteria-based decisions for calculating PRC flows.

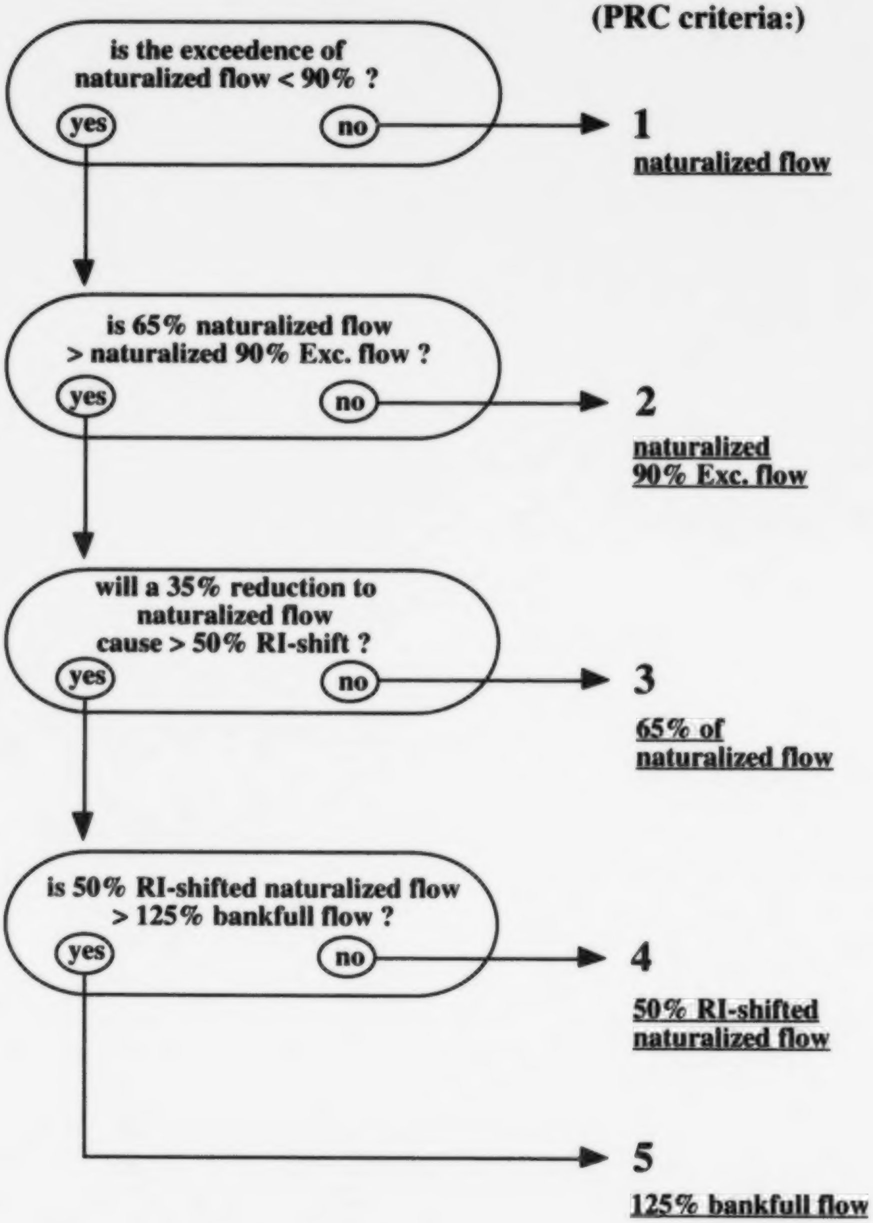

(PRC criteria:)
is the exceedence of naturalized flow < 90% ?
yes
no
1
naturalized flow
is 65% naturalized flow > naturalized 90% Exc. flow ?
yes
no
2
naturalized 90% Exc. flow
will a 35% reduction to naturalized flow cause > 50% RI-shift ?
yes
no
3
65% of naturalized flow
is 50% RI-shifted naturalized flow > 125% bankfull flow ?
yes
no
4
50% RI-shifted naturalized flow
5
125% bankfull flow

Figure 2. a) Example of a weekly PRC vs. a naturalized exceedence curve, for flows along the St. Mary River near Lethbridge during Julian week 24, and b) individual exceedence curves for each criterion of the PRC.

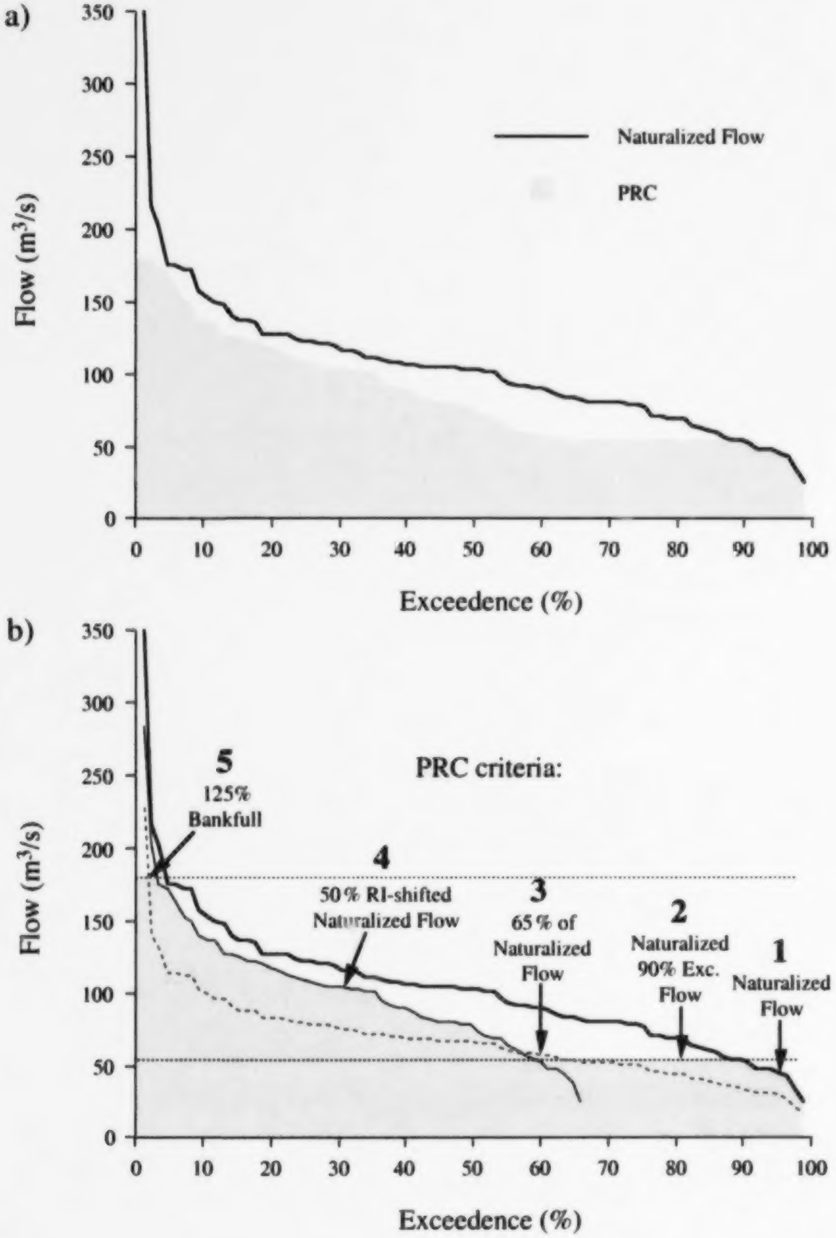


Figure 3. Generalized patterns of regulated flows that can result downstream from regulatory structures that are operated for a) hydropower generation, b) flow diversion, c) flow storage for later instream use, d) flood-control, or e) multiple uses.

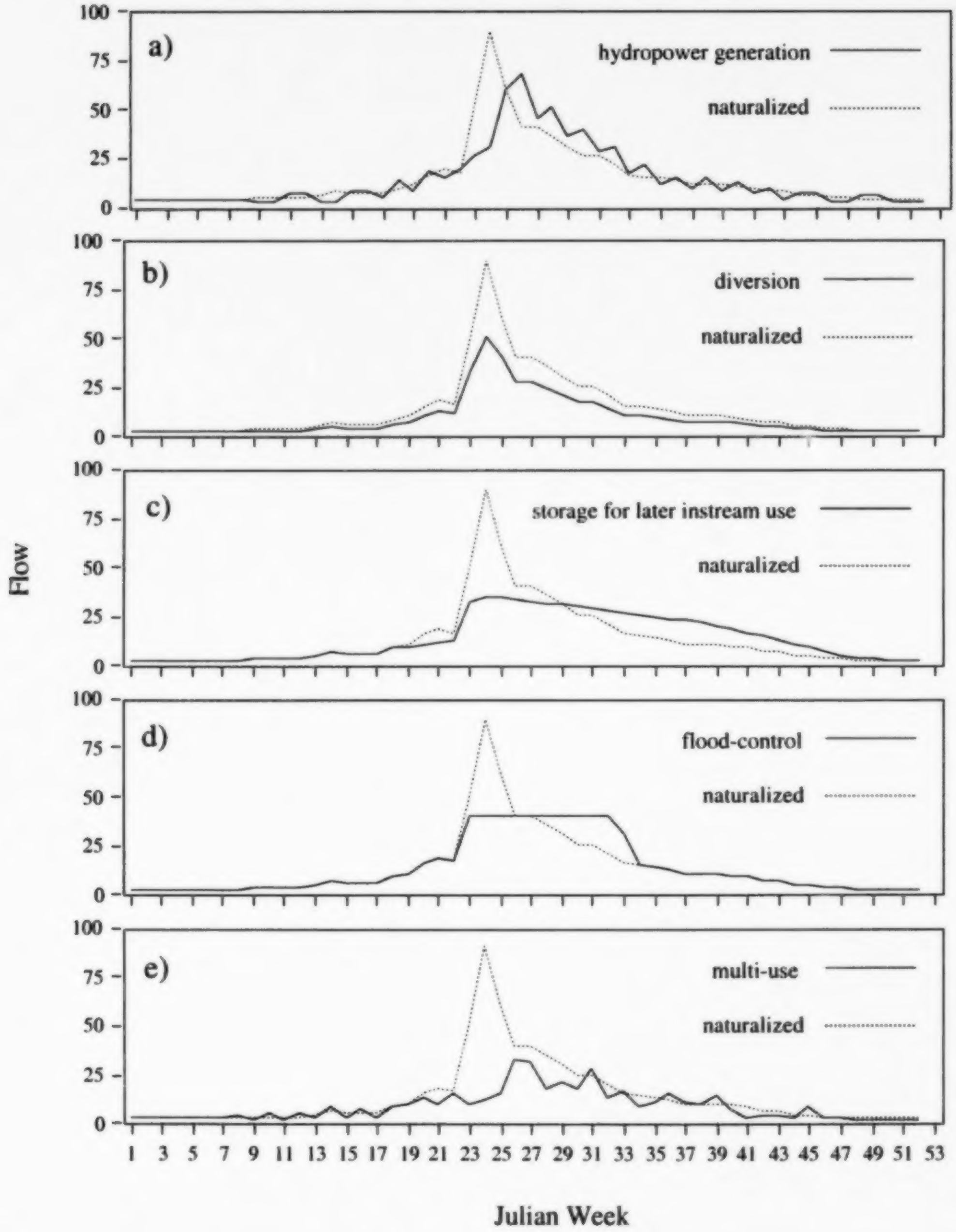


Figure 4. Major flow-regulatory structures and PRC study reaches in the SSRB (UWAT / LWAT = upper / lower Waterton River, UBEL / LBEL = upper / lower Belly River, USTM / LSTM = upper / lower St. Mary River).

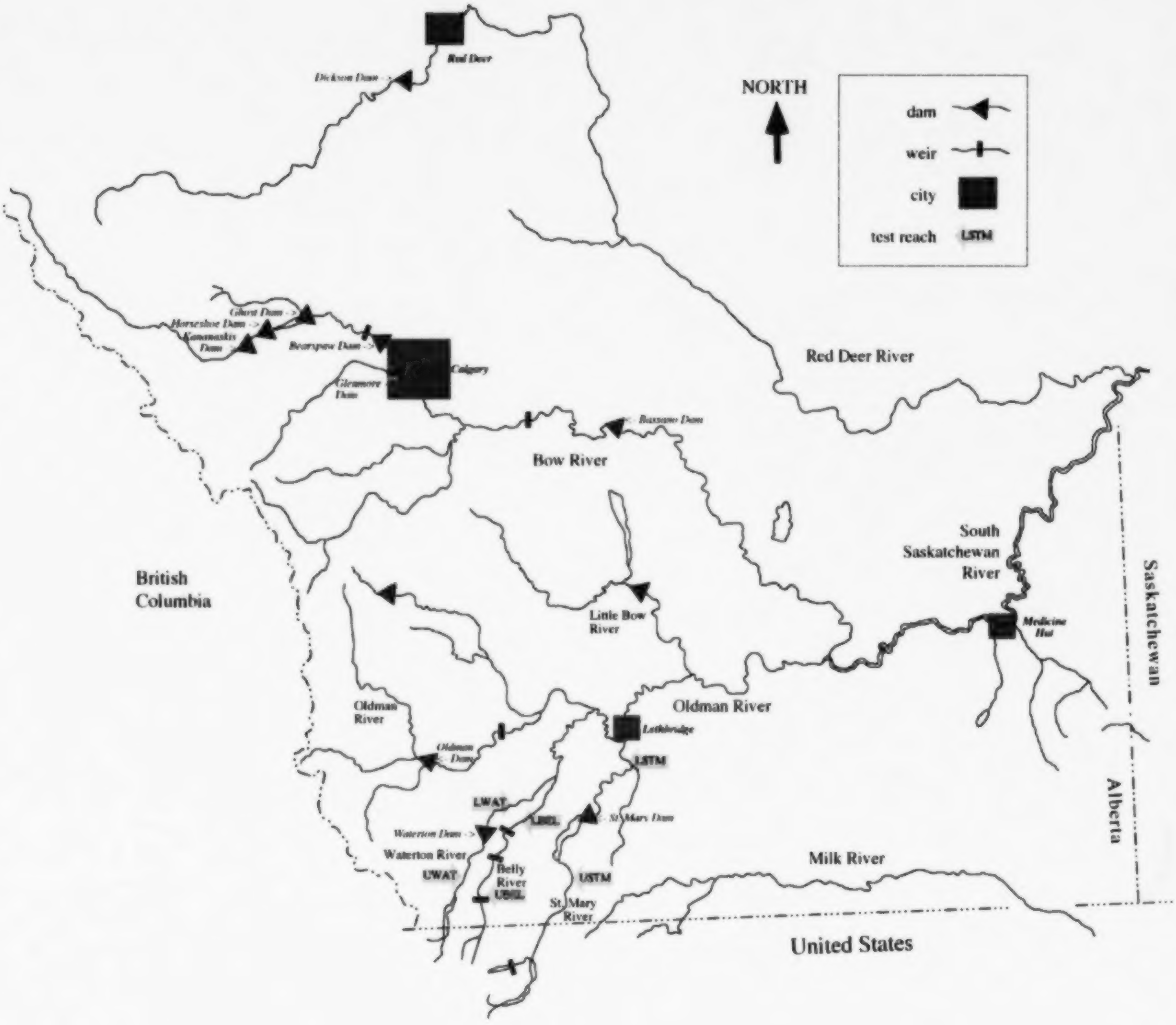

Red Deer
Dickson Dam ->
NORTH
dam
weir
city
test reach
LSTM
Ghost Dam ->
Horseshoe Dam ->
Kananaskis Dam ->
Bearspaw Dam ->
Calgary
Glenmore Dam
Red Deer River
<- Bassano Dam
Bow River
South Saskatchewan River
British Columbia
Little Bow River
Medicine Hat
Saskatchewan
Oldman River
Oldman River
Oldman Dam
Lethbridge
LSTM
LWAT
LBEL
<- St Mary Dam
Waterton Dam ->
Waterton River
UWAT
Belly River
UBEL
USTM
St. Mary River
Milk River
Alberta
United States

Figure 5. Geographic ranges of the cottonwood species that occur in the SSRB.

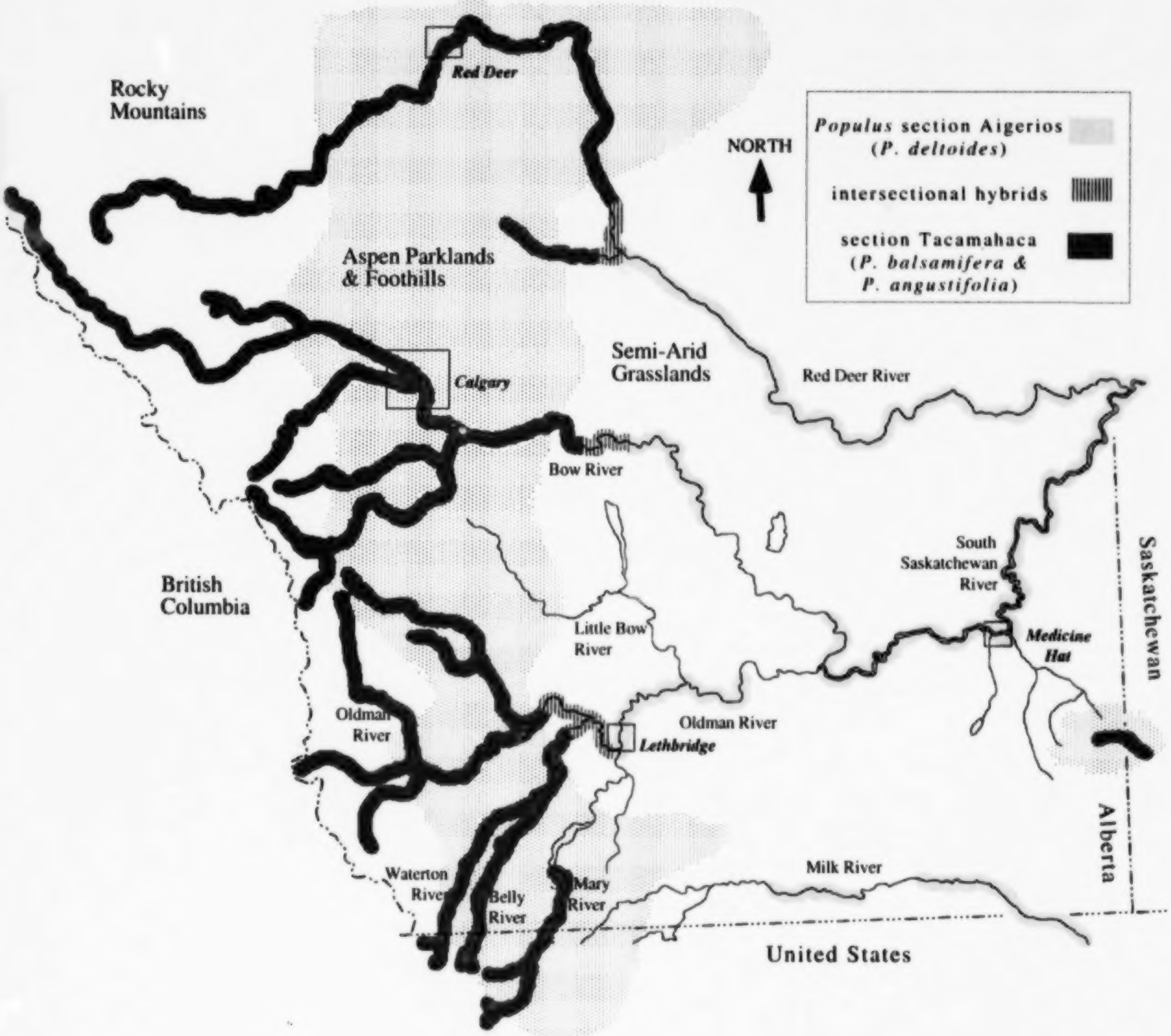

Rocky Mountains
Red Deer
Populus section Aigerios (P. deltoides)
intersectional hybrids
section Tacamahaca (P. balsamifera & P. angustifolia)
NORTH
Aspen Parklands & Foothills
Semi-Arid Grasslands
Calgary
Red Deer River
Bow River
South Saskatchewan River
Saskatchewan
British Columbia
Little Bow River
Medicine Hat
Oldman River
Oldman River
Lethbridge
Alberta
Milk River
Waterton River
Belly River
St. Mary River
United States

Figure 6. Excerpt from G.M. Dawson's 1884 map of southern Alberta showing the distribution of riparian forests (from Dawson 1885).

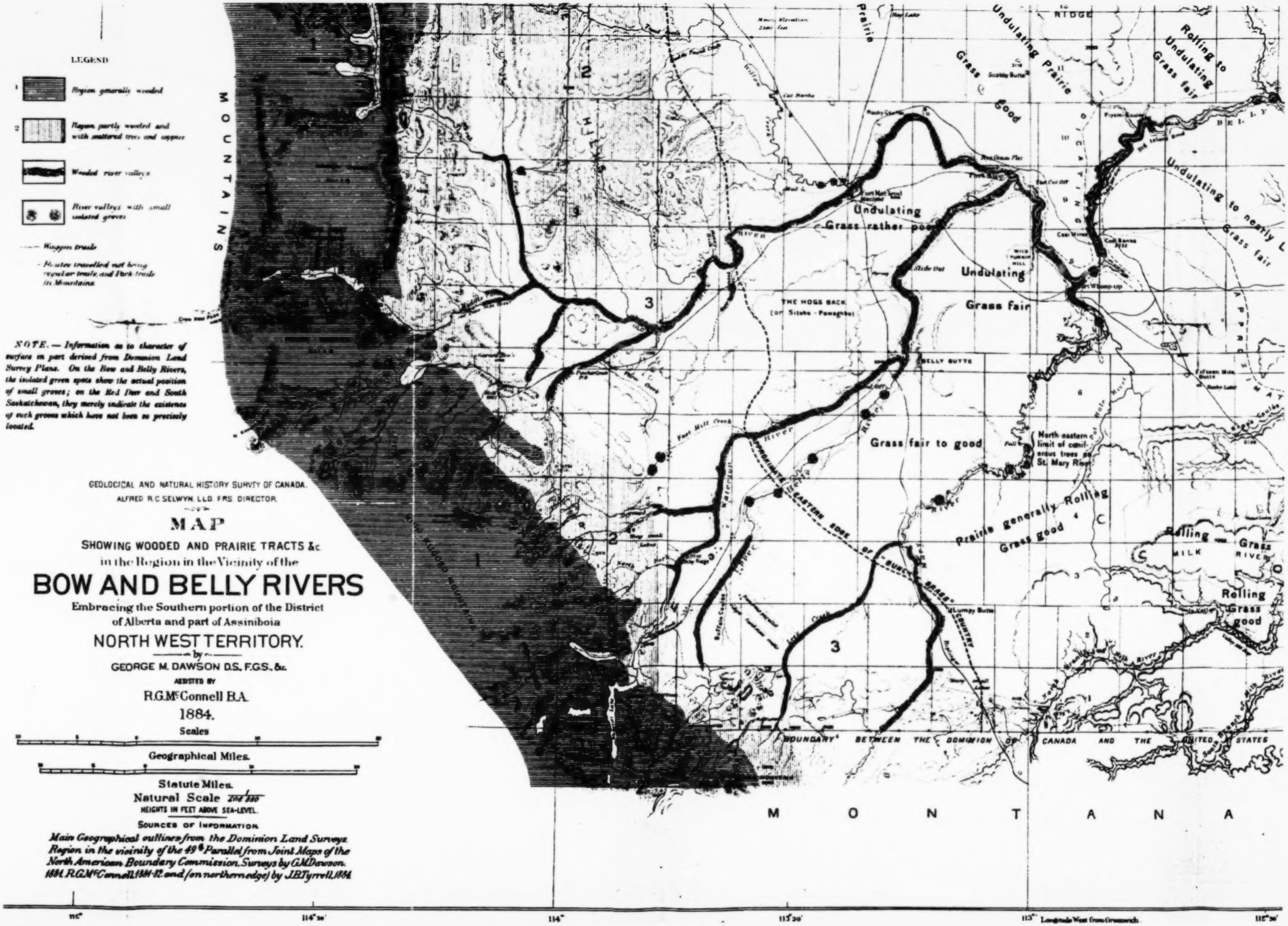
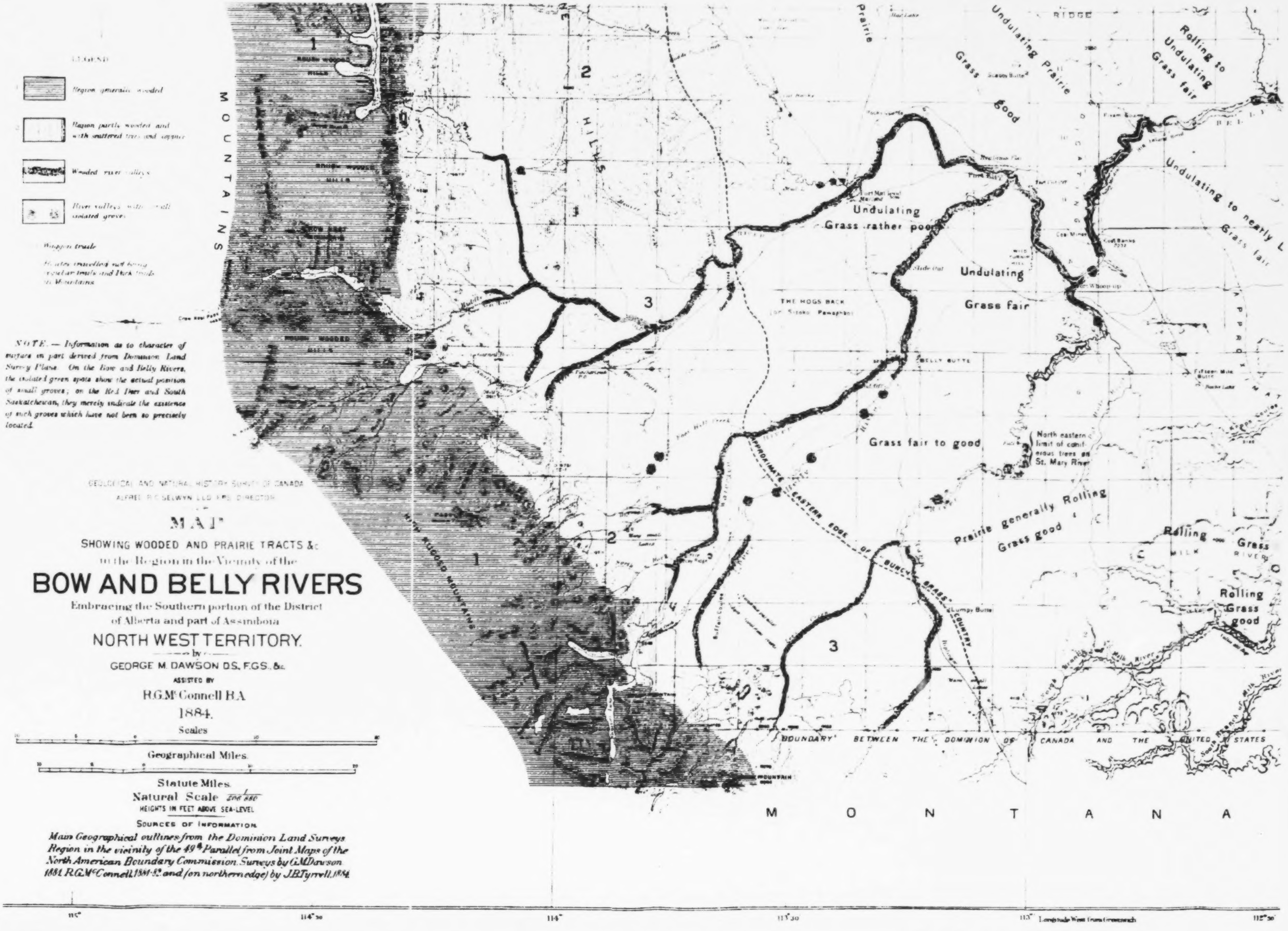

LEGEND
Region generally wooded
Region partly wooded and with scattered trees and coppice
Wooded river valleys
River valleys with small isolated groves
Waggon trails
Routes travelled not being regular trails, and Pack trails in Mountains
NOTE. — Information as to character of surface in part derived from Dominion Land Survey Plans. On the Bow and Belly Rivers, the isolated green spots show the actual position of small groves; on the Red Deer and South Saskatchewan, they merely indicate the existence of such groves which have not been so precisely located.
GEOLOGICAL AND NATURAL HISTORY SURVEY OF CANADA.
ALFRED R.C. SELWYN, LLD. FRS. DIRECTOR.
MAP
SHOWING WOODED AND PRAIRIE TRACTS &c
in the Region in the Vicinity of the
BOW AND BELLY RIVERS
Embracing the Southern portion of the District of Alberta and part of Assiniboia
NORTH WEST TERRITORY.
by
GEORGE M. DAWSON D.S., F.G.S., &c.
ASSISTED BY
R.G.McConnell B.A.
1884.
Scales
Geographical Miles.
Statute Miles.
Natural Scale
HEIGHTS IN FEET ABOVE SEA-LEVEL.
SOURCES OF INFORMATION.
Main Geographical outlines from the Dominion Land Surveys. Region in the vicinity of the 49th Parallel from Joint Maps of the North American Boundary Commission. Surveys by G.M.Dawson, 1884. R.G.McConnell, 1881-82 and (on northern edge) by J.B.Tyrrell, 1884.
MOUNTAINS
HILLS
Prairie
RIDGE
Undulating Prairie
Grass Good
Rolling to Undulating Grass fair
BELLY
Undulating to nearly L
Grass fair
Undulating Grass rather poor
Undulating Grass fair
RIVER
THE HOGS BACK (or Sitoko - Pawaghko)
BELLY BUTTE
Grass fair to good
North-eastern limit of coniferous trees on St. Mary River
Prairie generally Rolling Grass good
Rolling Grass
MILK RIVER
Rolling Grass good
Milk River
BOUNDARY BETWEEN THE DOMINION OF CANADA AND THE UNITED STATES
MONTANA
Fort Macleod
Crow Nest Pass
Waterton
Lee Creek
Old Man River
Scabby Butte
Pincher Creek
1
2
3
4
6
11
115°
114°30'
114°
113°30'
113°
112°30'
Longitude West from Greenwich

Figure 6. Excerpt from G.M. Dawson's 1884 map of southern Alberta showing the distribution of riparian forests (from Dawson 1885).


LEGEND
Region generally wooded
Region partly wooded and with scattered trees and copses
Wooded river valleys
River valleys with small isolated groves
Waggon trails
NOTE. — Information as to character of surface in part derived from Dominion Land Survey Plans. On the Bow and Belly Rivers, the isolated green spots show the actual position of small groves; on the Red Deer and South Saskatchewan, they merely indicate the existence of such groves which have not been so precisely located.
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MOUNTAINS
HILLS
1
2
3
ROUGH WOODED HILLS
Prairie
Undulating Prairie
Grass good
RIDGE
Rolling to Undulating Grass fair
Undulating to nearly L
Grass fair
Undulating Grass rather poor
Undulating Grass fair
THE HOGS BACK
BELLY BUTTE
Whoop up
Fort Macleod
Grass fair to good
North eastern limit of coniferous trees on St. Mary River
APPROXIMATE EASTERN EDGE OF BUNCH GRASS COUNTRY
Prairie generally Rolling Grass good
Rolling Grass
MILK RIVER
Rolling Grass good
PORCUPINE HILLS
Lumpy Butte
BOUNDARY BETWEEN THE DOMINION OF CANADA AND THE UNITED STATES
M O N T A N A
115°
114°30
114°
113°30
113° Longitude West from Greenwich
112°30'

Figure 7. Naturalized vs. actual weekly flows during a high flow year (1975), a low flow year (1977), and two average flow years (1976 & 1978) along the upper (left) and lower (right) reaches of the Belly River (at Mountain View and Standoff respectively).

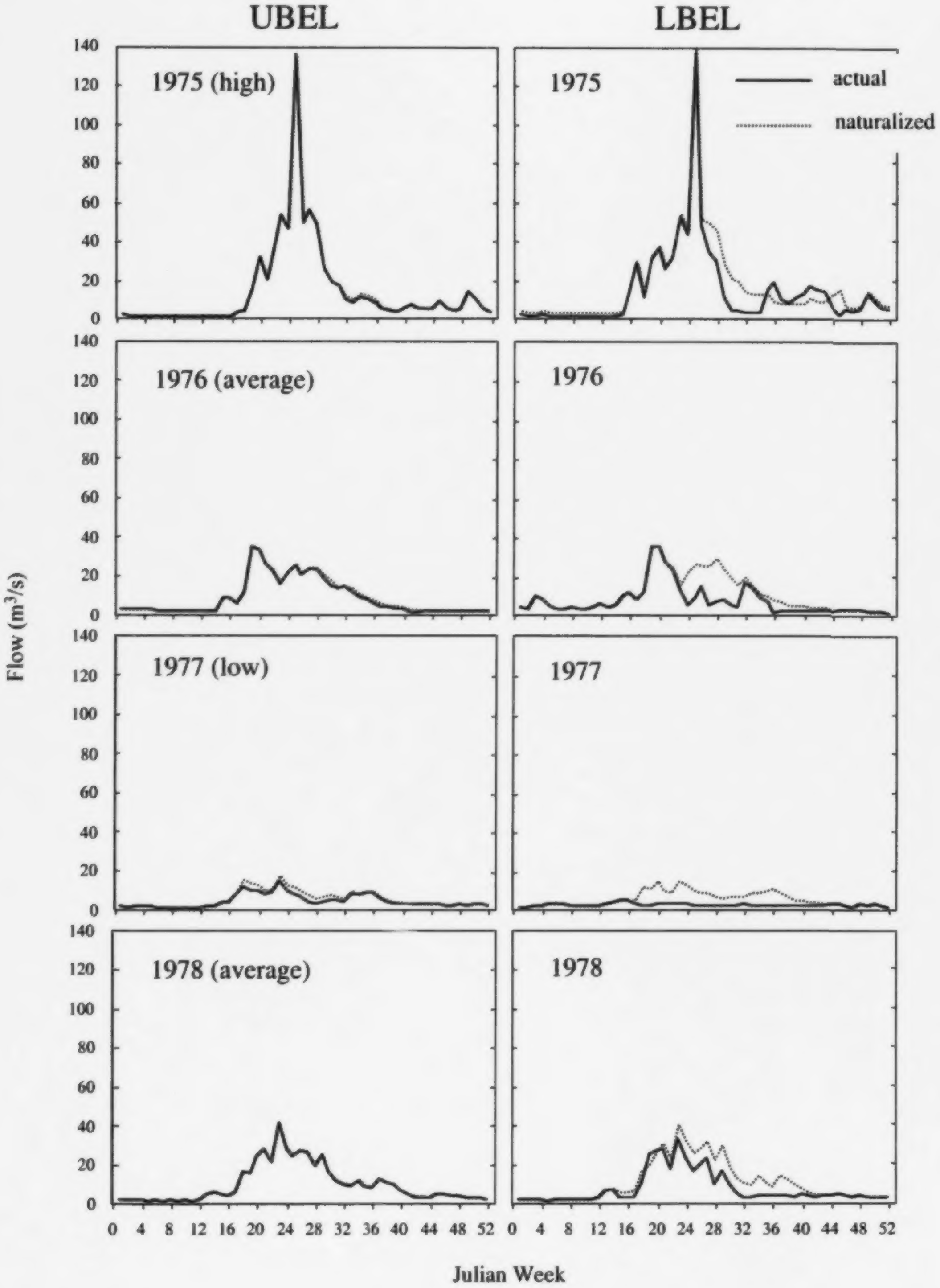
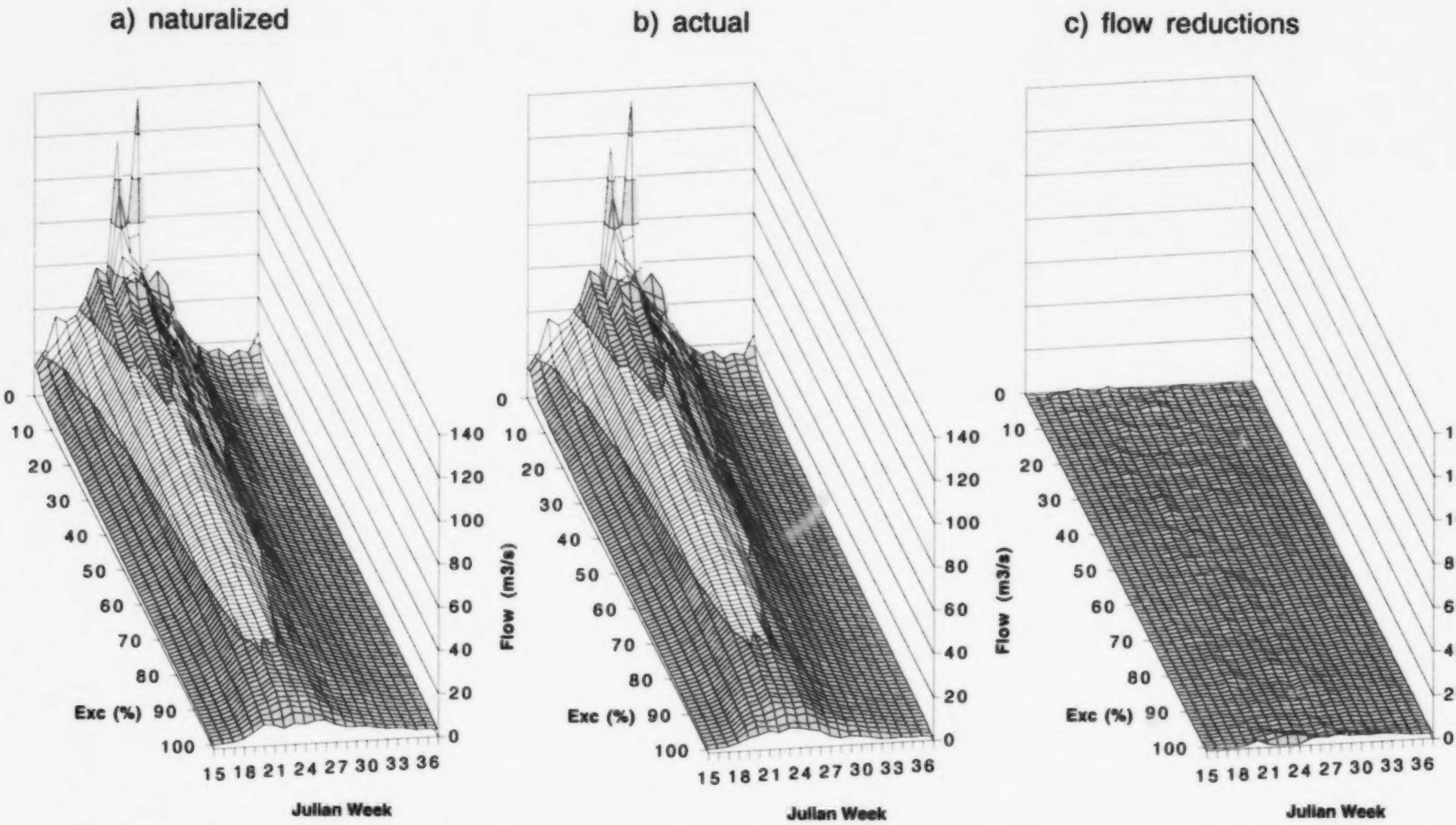


Figure 8. Exceedences of naturalized flows, actual flows, and flow reductions during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the upper Belly River (at Mountain View).

UBEL



a) naturalized

b) actual

c) flow reductions

Figure 9. Exceedences of naturalized flows, actual flows, and flow reductions during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the lower Belly River (at Standoff & Glenwood).

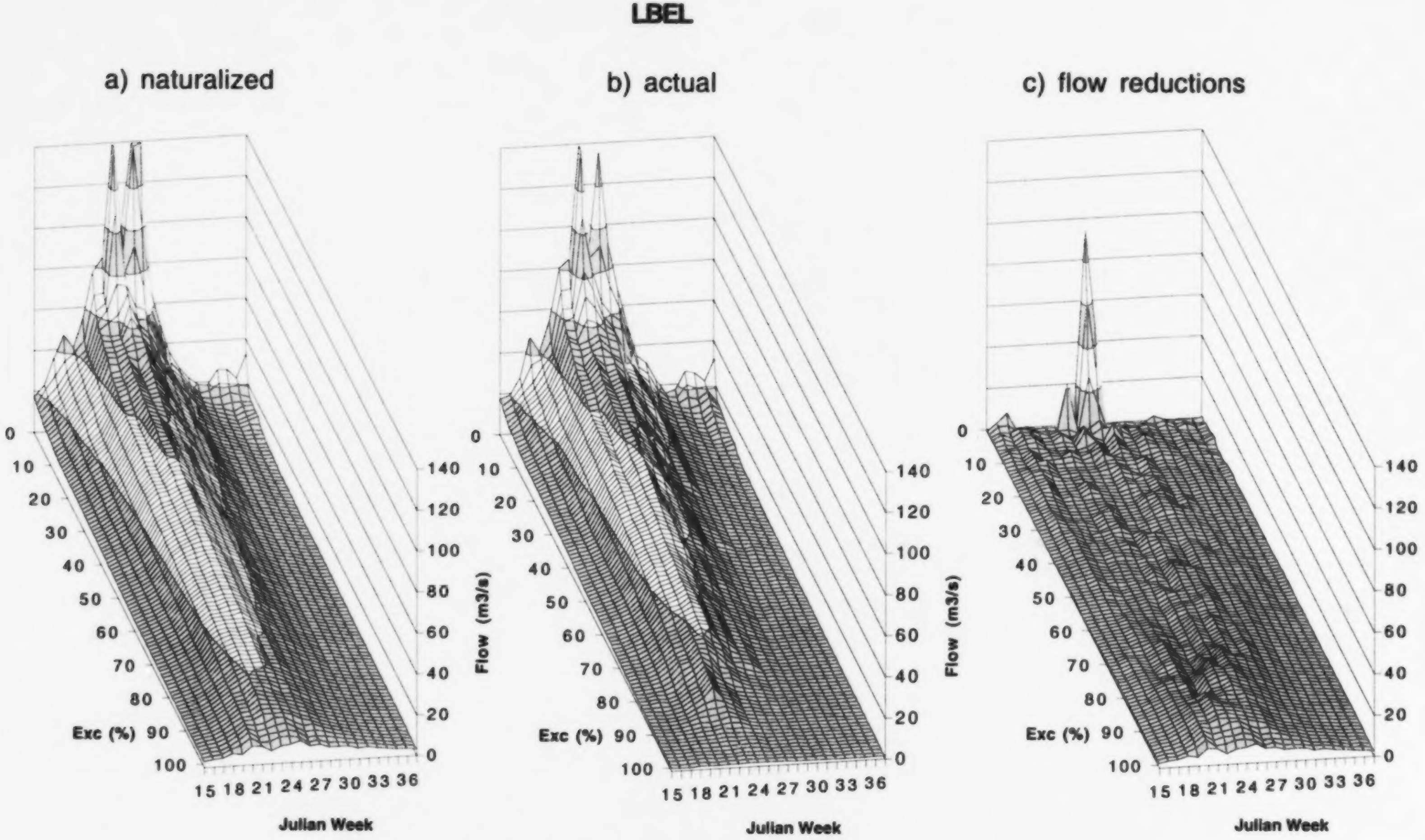


Figure 10. Changes in area and density of poplar communities from 1951 to 1990 as reported by Reid et al. (1992) (UBEL / LBEL = upper / lower Belly River, UWAT / LWAT = upper / lower Waterton River, USTM / LSTM = upper / lower St. Mary River).

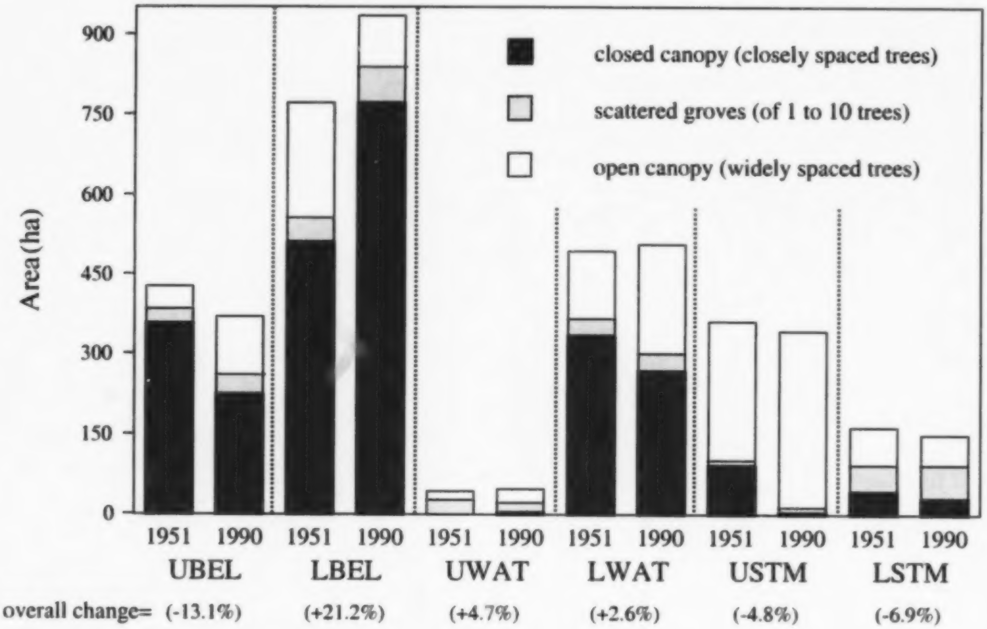


Figure 11. Naturalized vs. actual weekly flows during a high flow year (1975), a low flow year (1977), and two average flow years (1976 & 1978) along the upper (left) and lower (right) reaches of the Waterton River (at Waterton Park and Glenwood respectively).

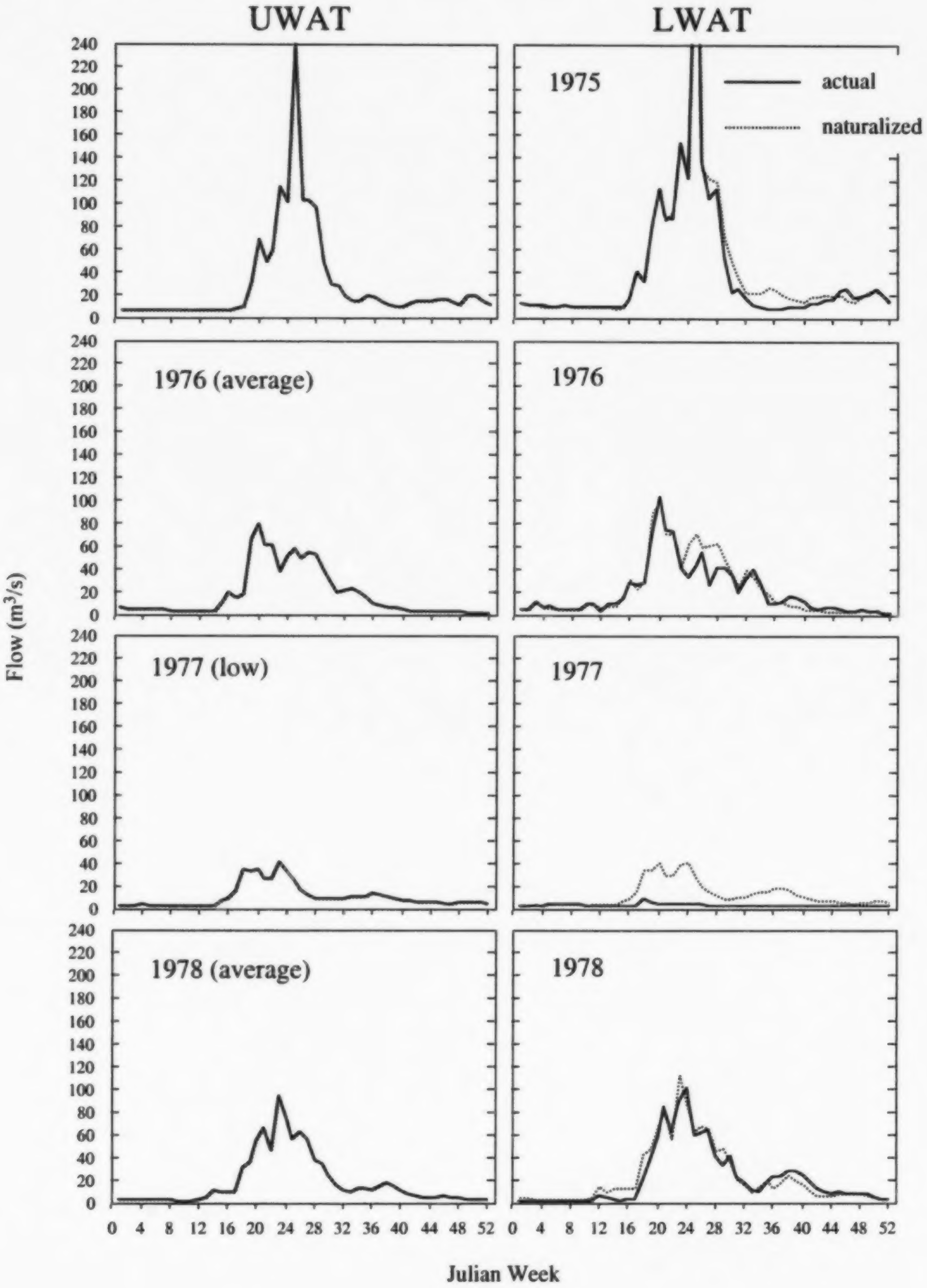


Figure 12. Exceedences of naturalized flows, actual flows, and flow reductions during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the upper Waterton River (at Waterton Park).

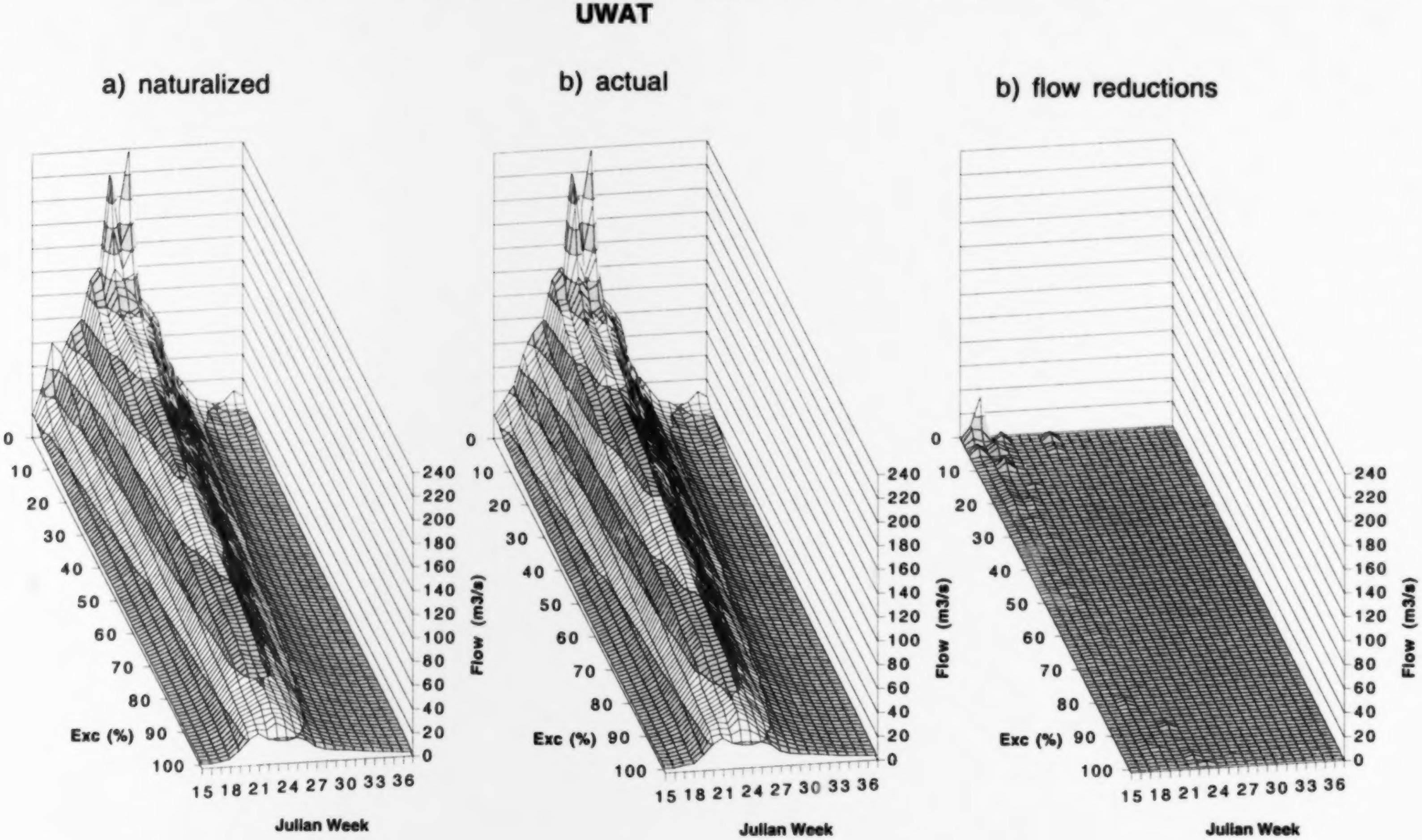
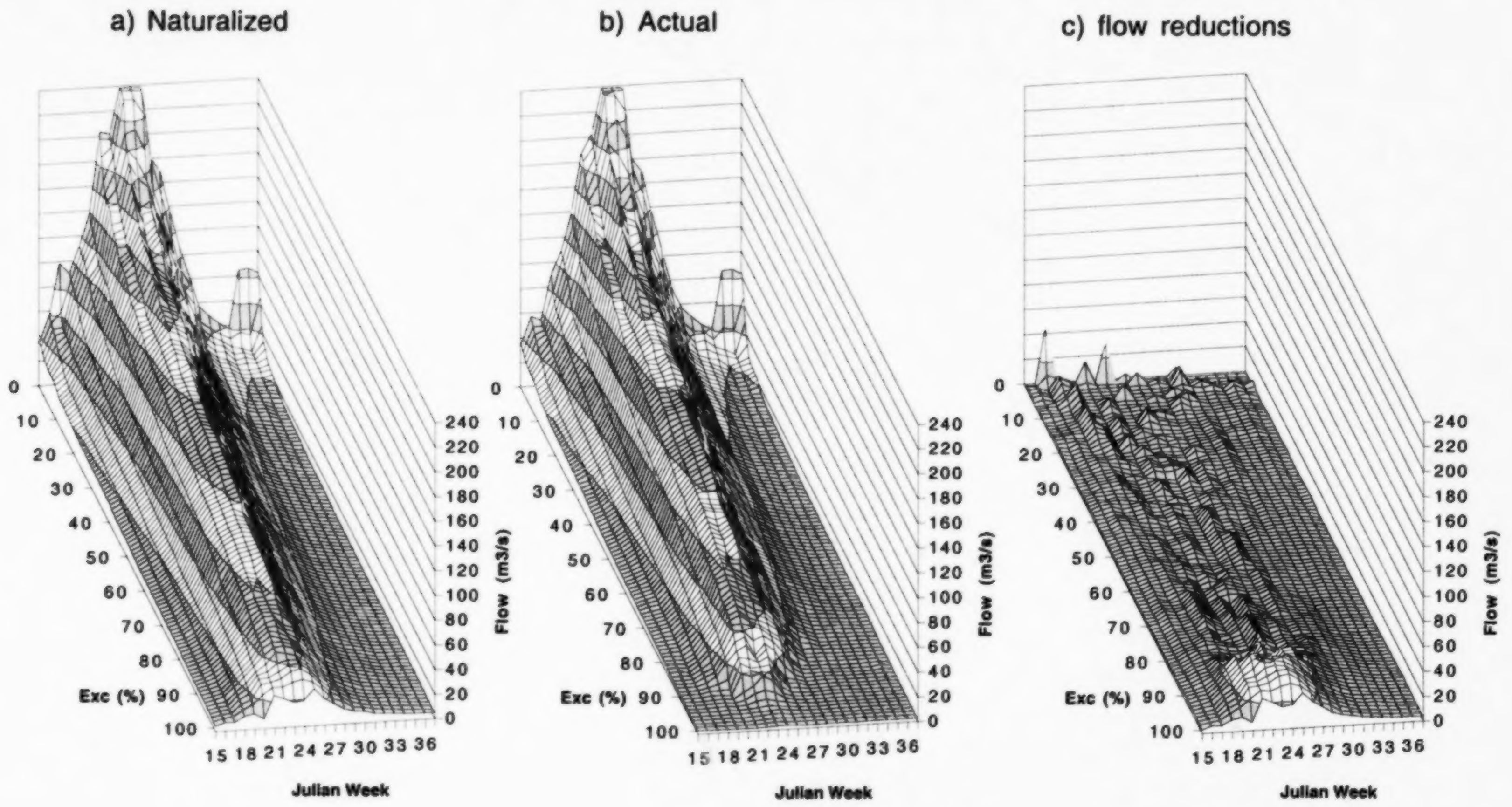


Figure 13. Exceedences of naturalized flows, actual flows, and flow reductions during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the lower Waterton River (at Standoff and Glenwood).

LWAT



a) Naturalized

b) Actual

c) flow reductions

Figure 14. Naturalized vs. actual weekly flows during a high flow year (1975), a low flow year (1977), and two average flow years (1976 & 1978) along the upper (left) and lower (right) reaches of the St. Mary River (at US / Canada border and Lethbridge respectively).

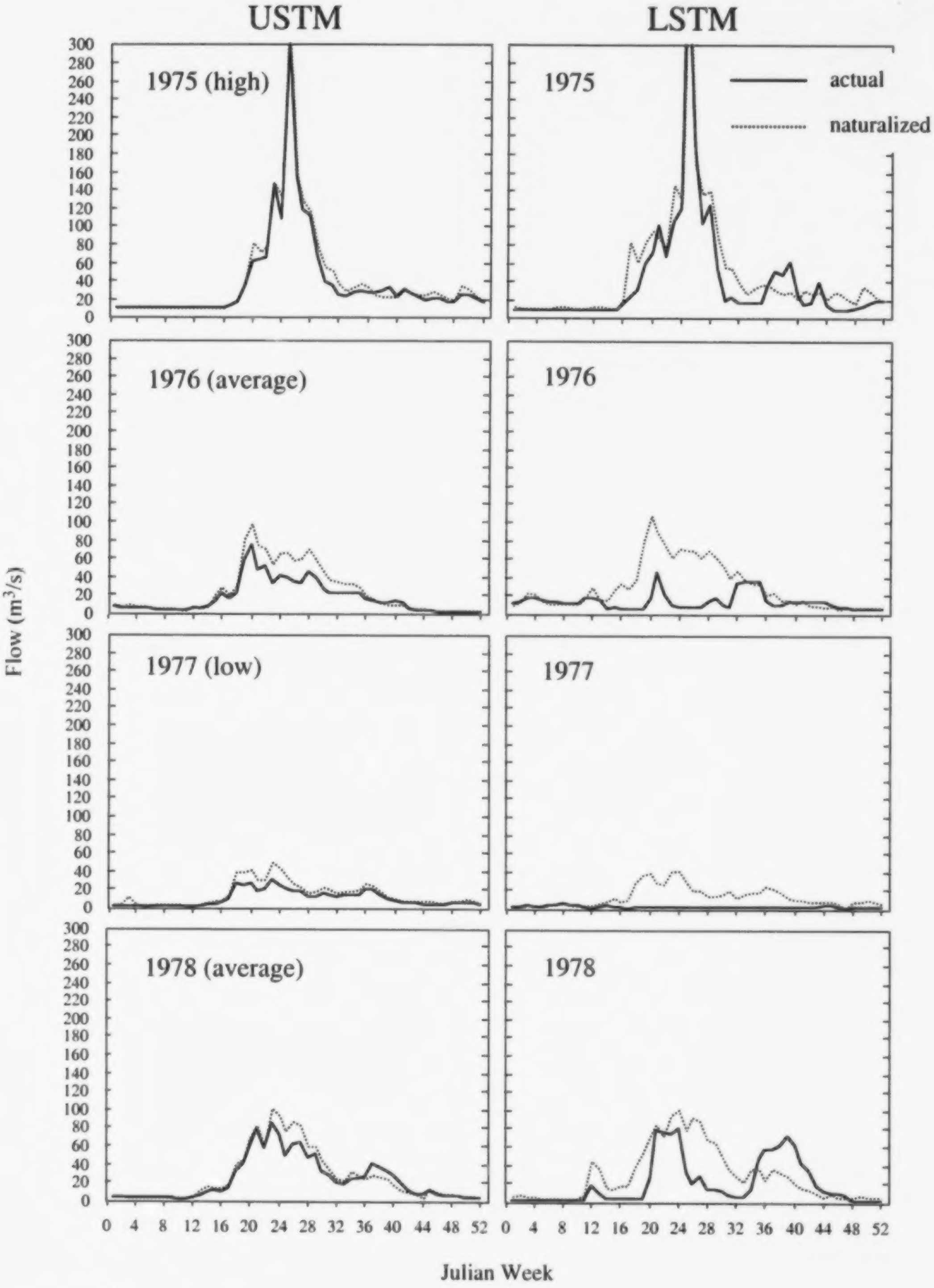


Figure 15. Exceedences of naturalized flows, actual flows, and flow reductions during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the upper St. Mary River (at US / Canada border).

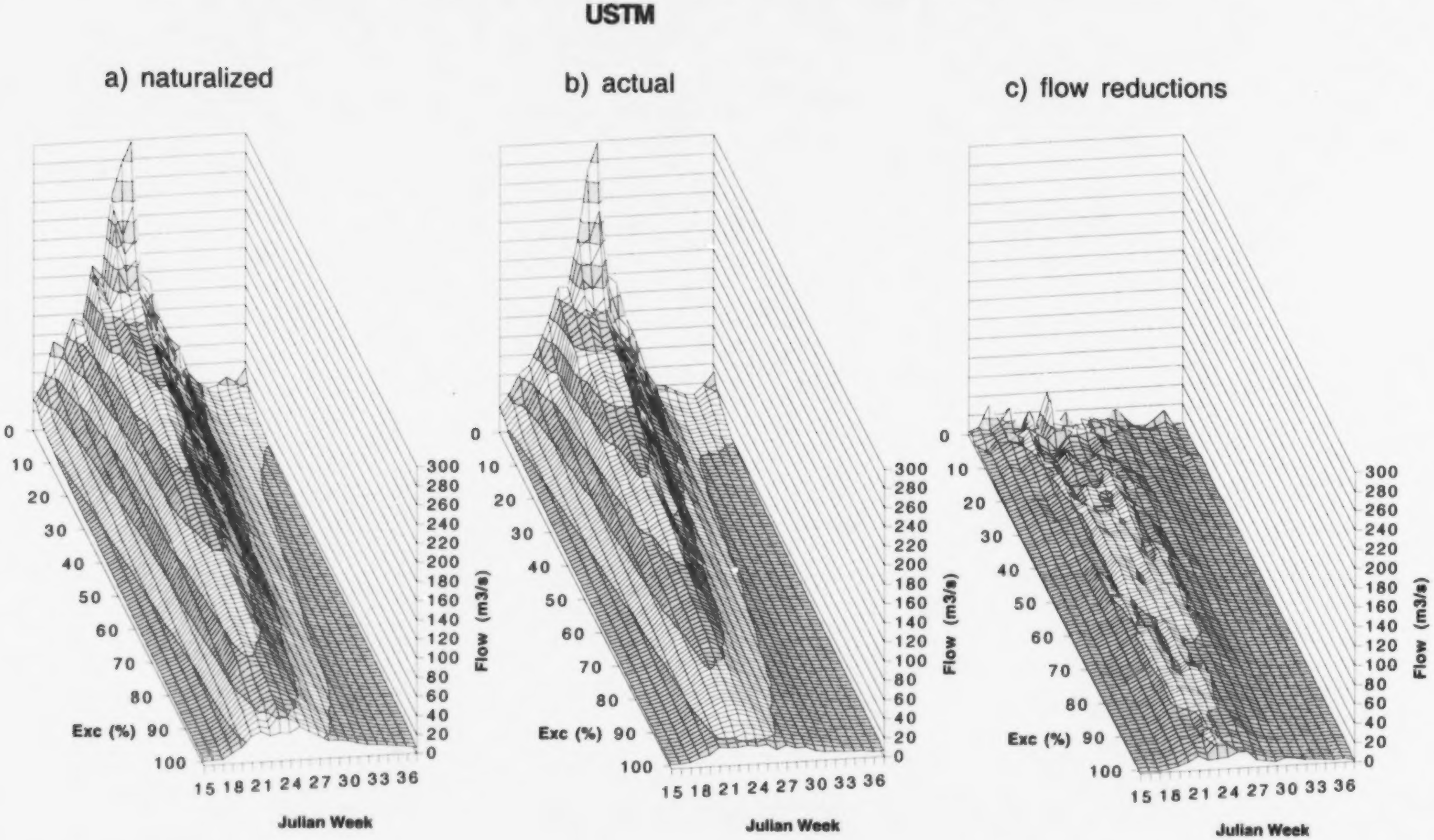


Figure 16. Exceedences of naturalized flows, actual flows, and flow reductions during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the lower St. Mary River (at Lethbridge).

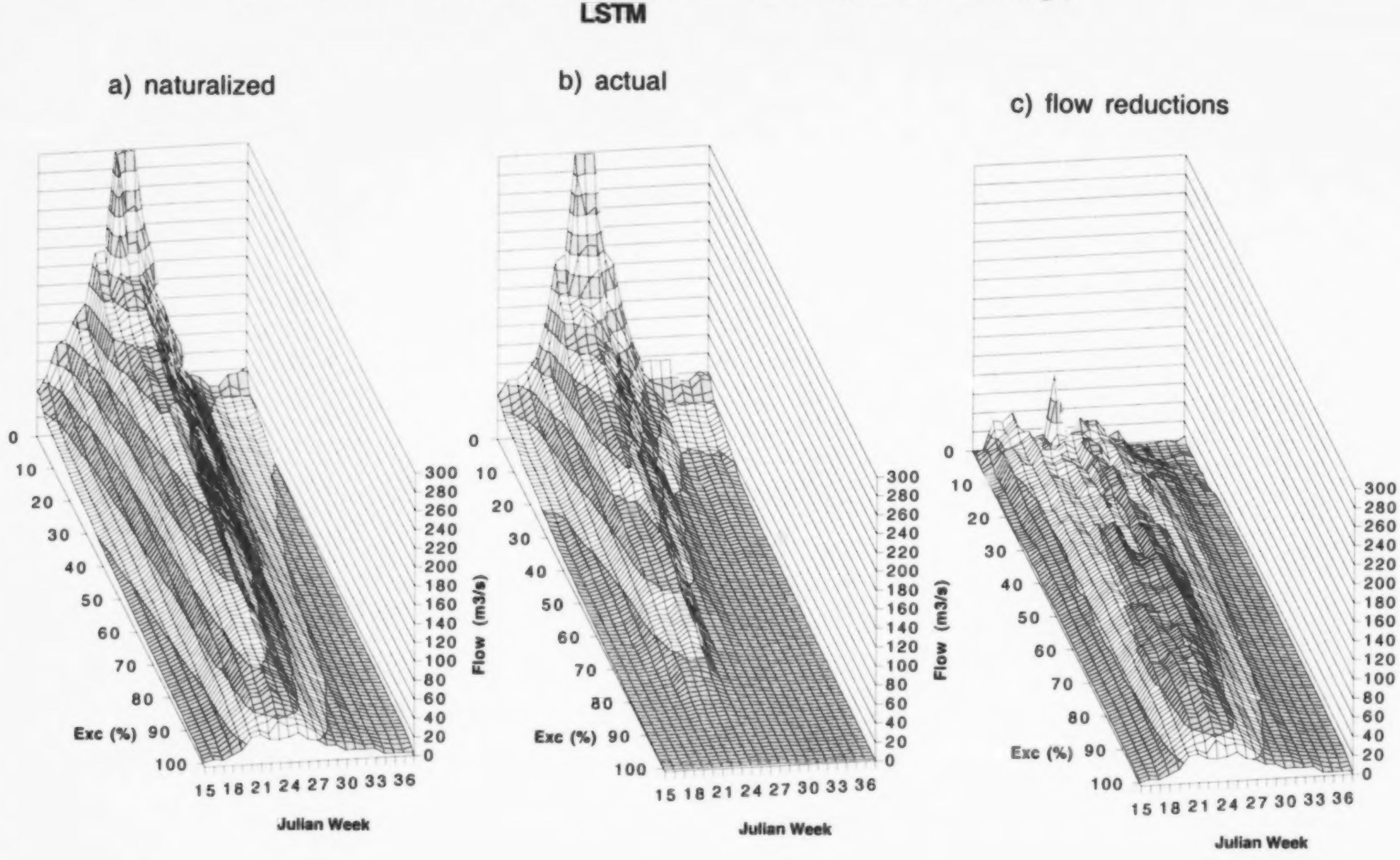


Figure 17. Actual vs. PRC weekly flows during a high flow year (1975), a low flow year (1977), and two average flow years (1976 & 1978) along the upper (left) and lower (right) reaches of the Belly River (at Mountain View and Standoff respectively).

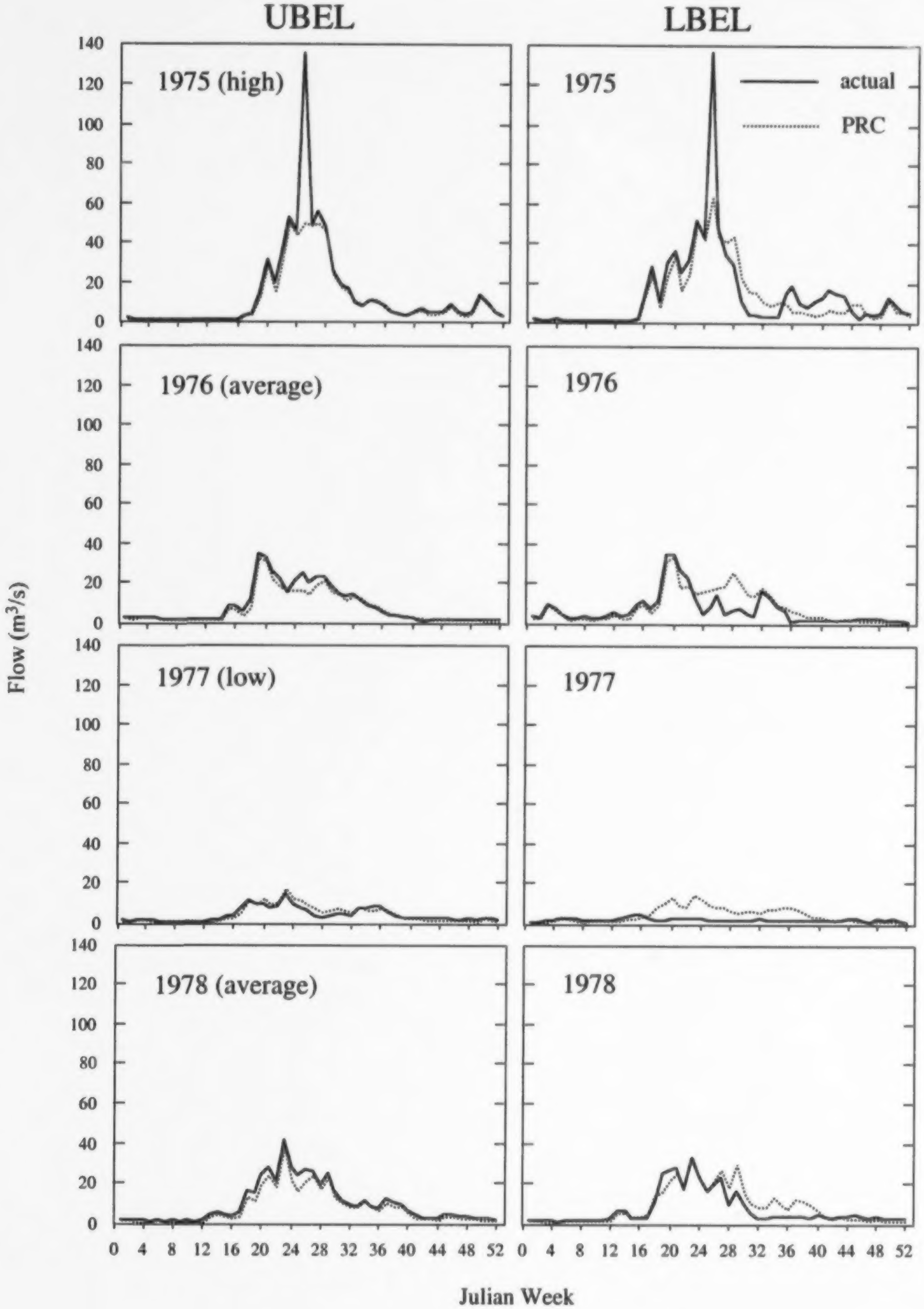


Figure 18. Exceedences of actual flows, PRC flows, and PRC reductions to actual flows during the cottonwood growing seaso (Julian weeks 15-37) of 1912-1995 along the upper Belly River (at Mountain View).

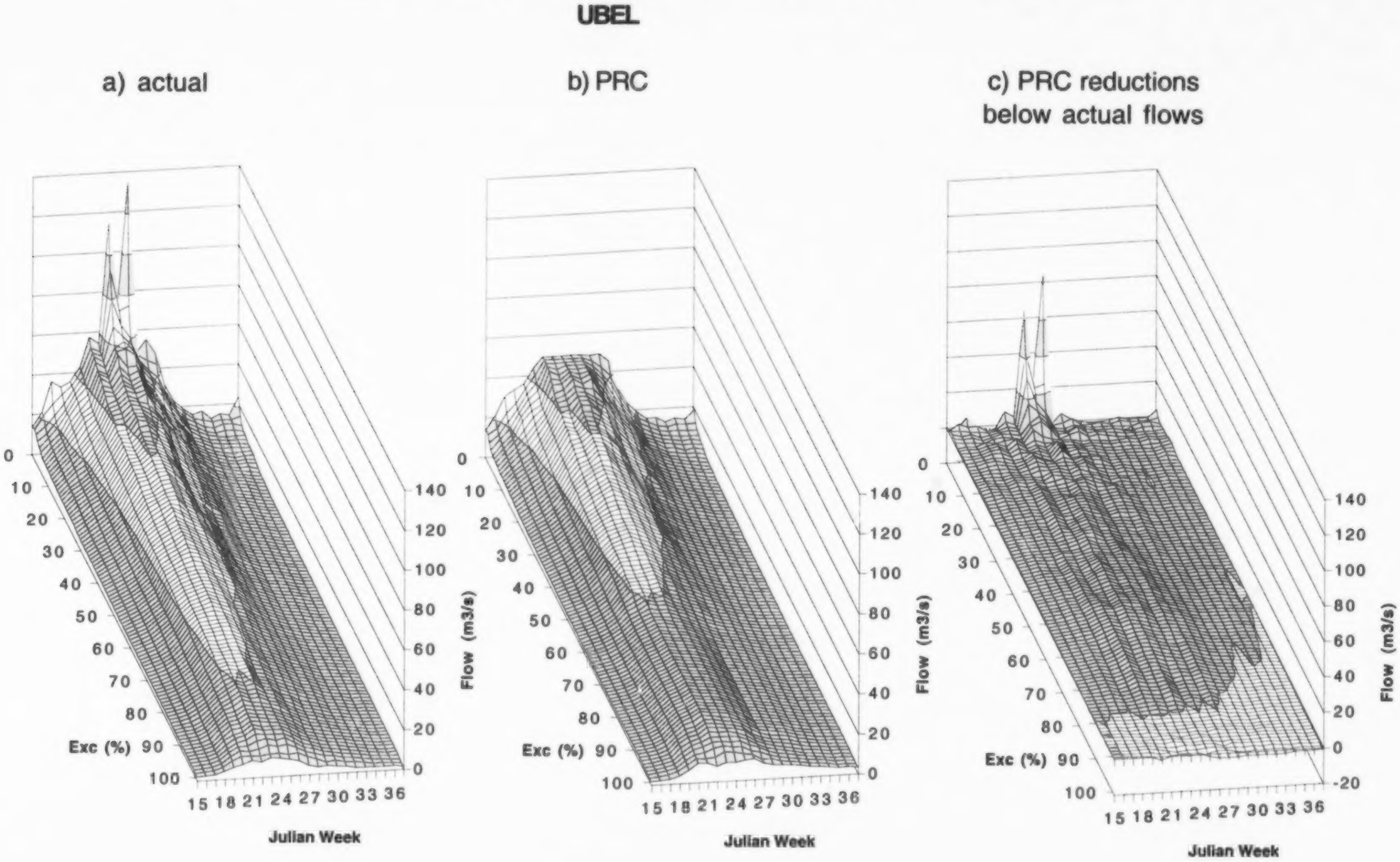
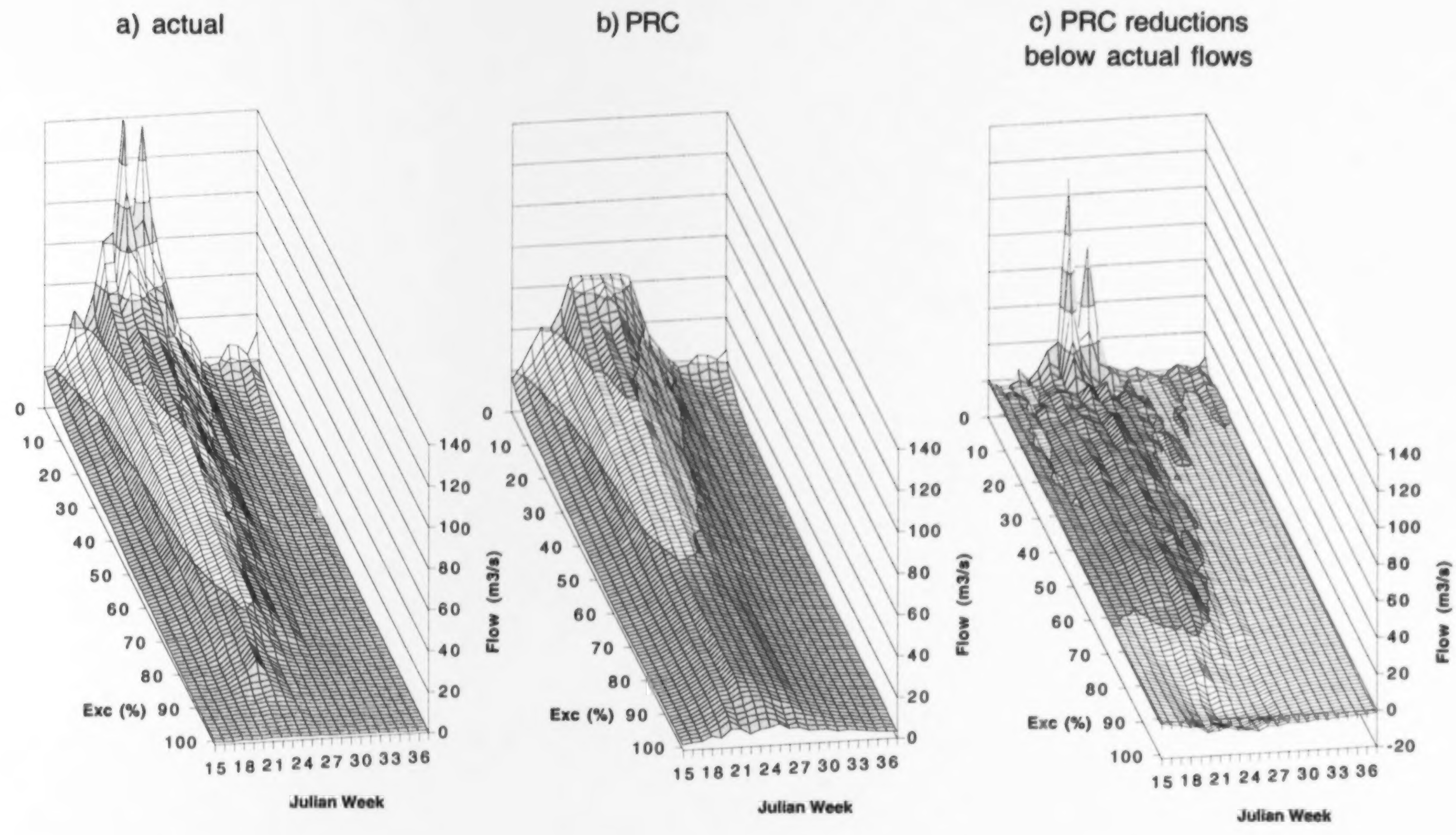


Figure 19. Exceedences of actual flows, PRC flows, and PRC reductions to actual flows during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the lower Belly River (at Standoff and Glenwood).

LBEL



a) actual

b) PRC

c) PRC reductions below actual flows

Figure 20. Actual vs. PRC weekly flows during a high flow year (1975), a low flow year (1977), and two average flow years (1976 & 1978) along the upper (left) and lower (right) reaches of the Waterton River (at Waterton Park and Glenwood respectively).

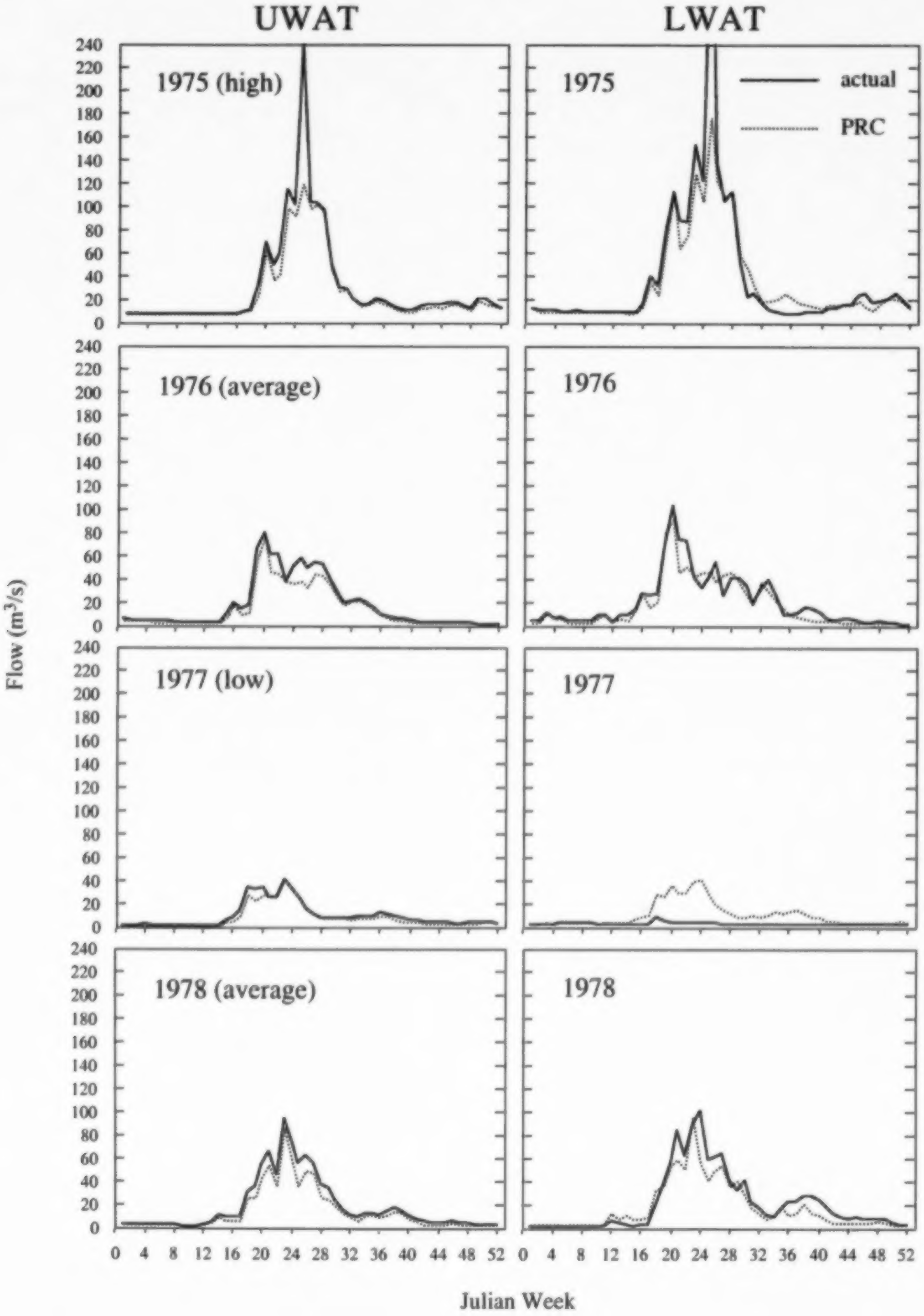
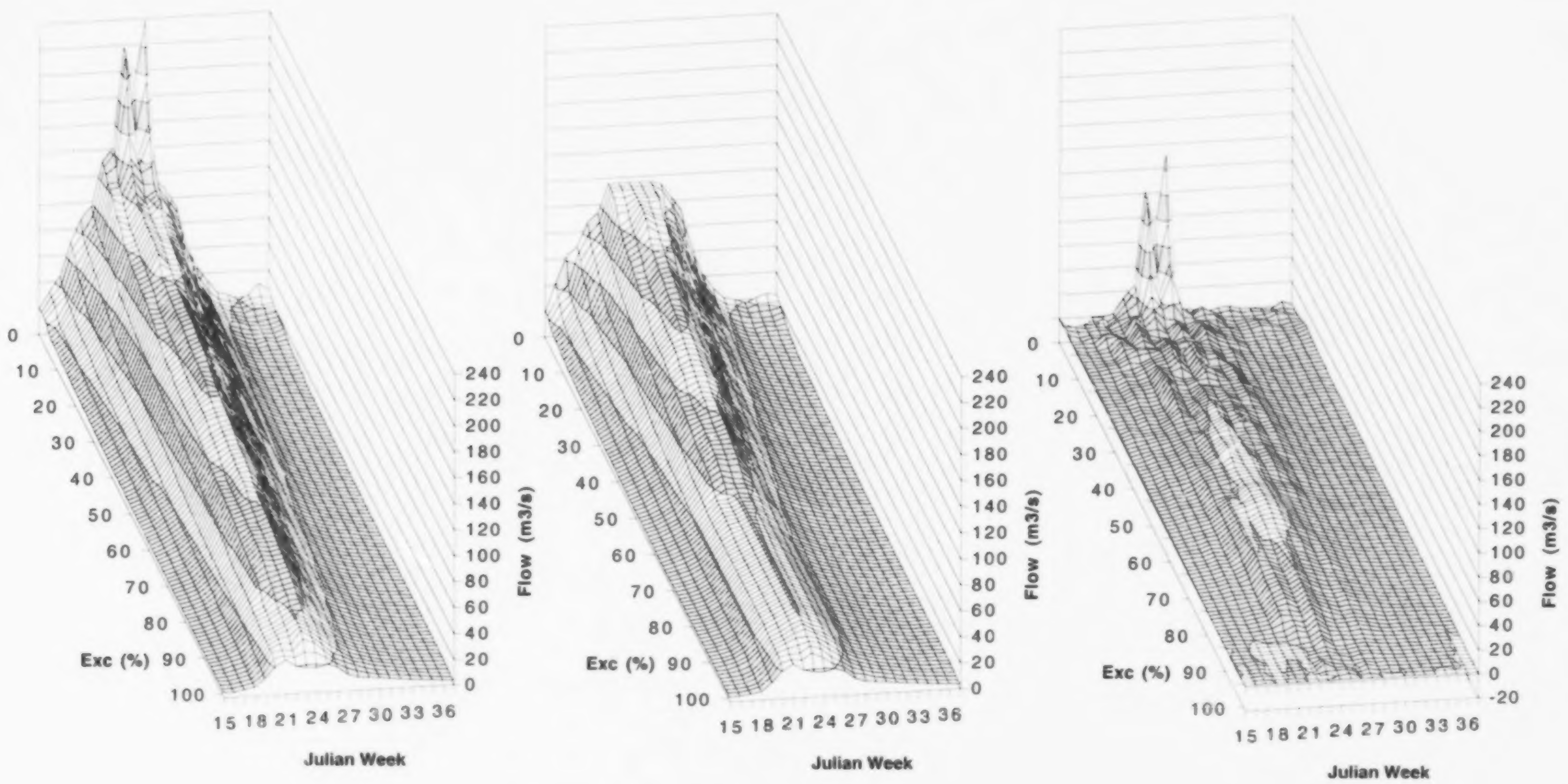


Figure 21. Exceedences of actual flows, PRC flows, and PRC reductions to actual flows during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the upper Waterton River (at Waterton Park).



UWAT

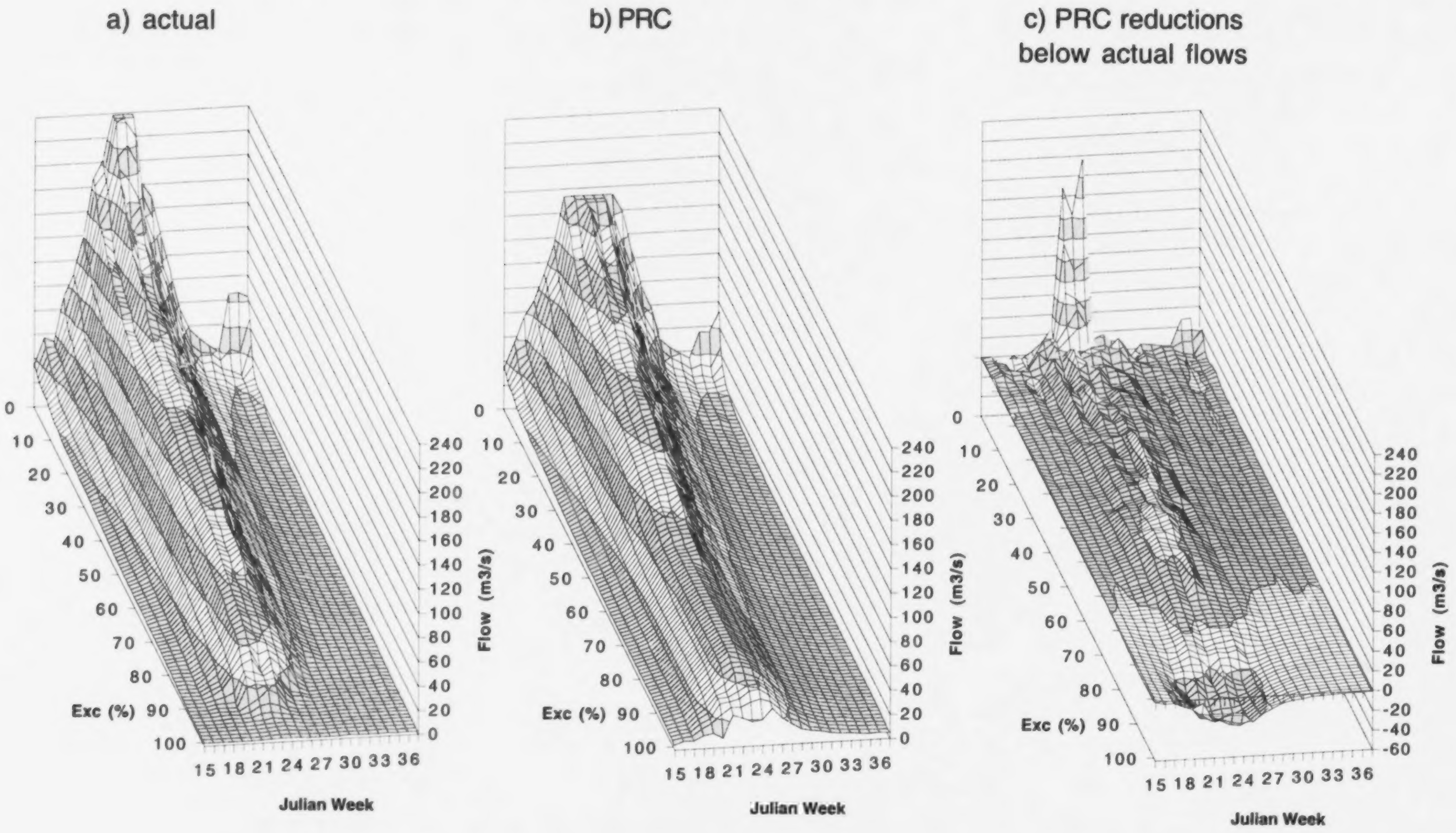
a) actual

b) PRC

c) PRC reductions below actual flows

Figure 22. Exceedences of actual flows, PRC flows, and PRC reductions to actual flows during the cottonwood growing seaso (Julian weeks 15-37) of 1912-1995 along the lower Waterton River (at Standoff and Glenwood).

LWAT

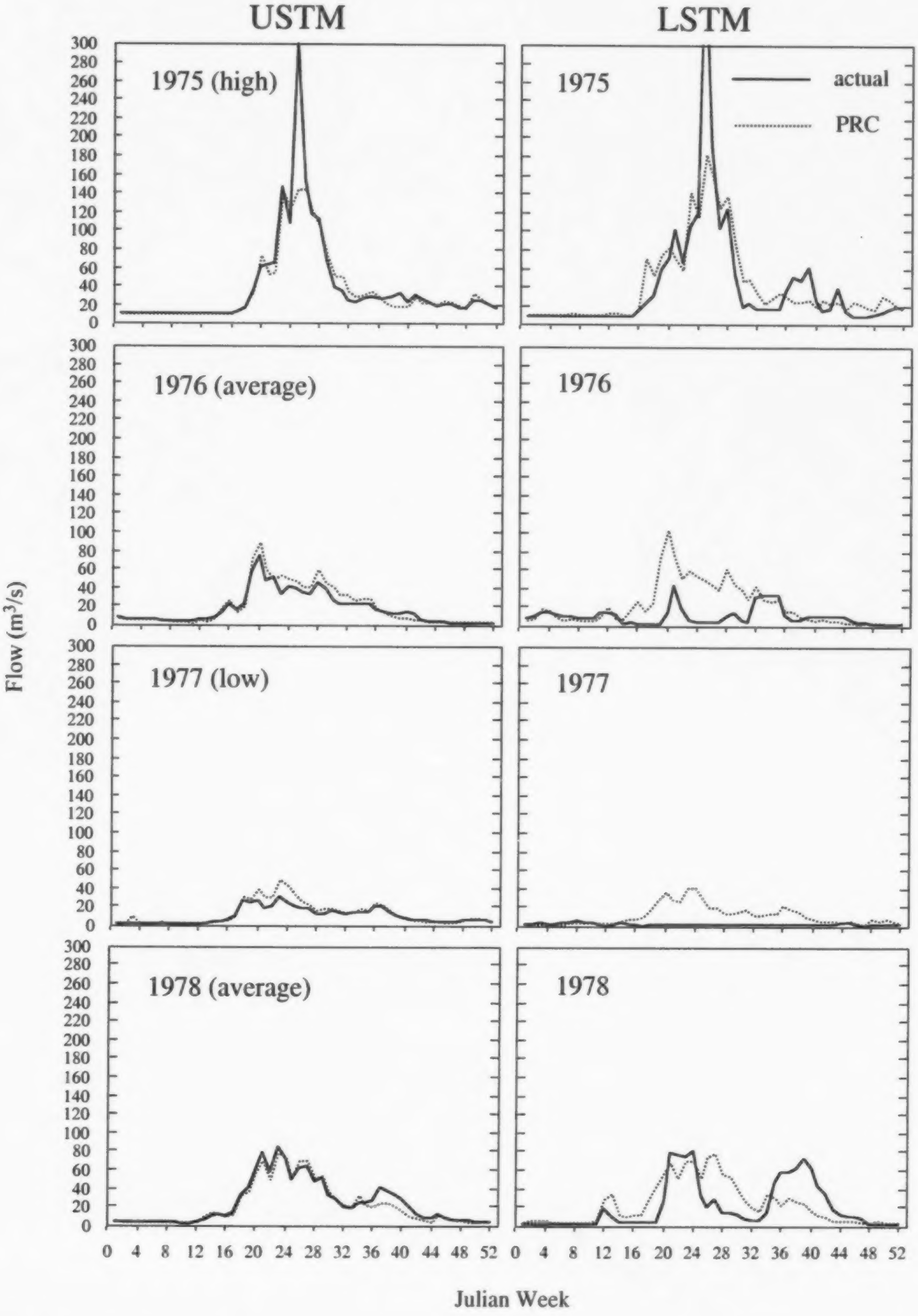


a) actual

b) PRC

c) PRC reductions below actual flows

Figure 23. Actual vs. PRC weekly flows during a high flow year (1975), a low flow year (1977), and two average flow years (1976 & 1978) along the upper (left) and lower (right) reaches of the St. Mary River (at the US / Canada border and Lethbridge respectively).



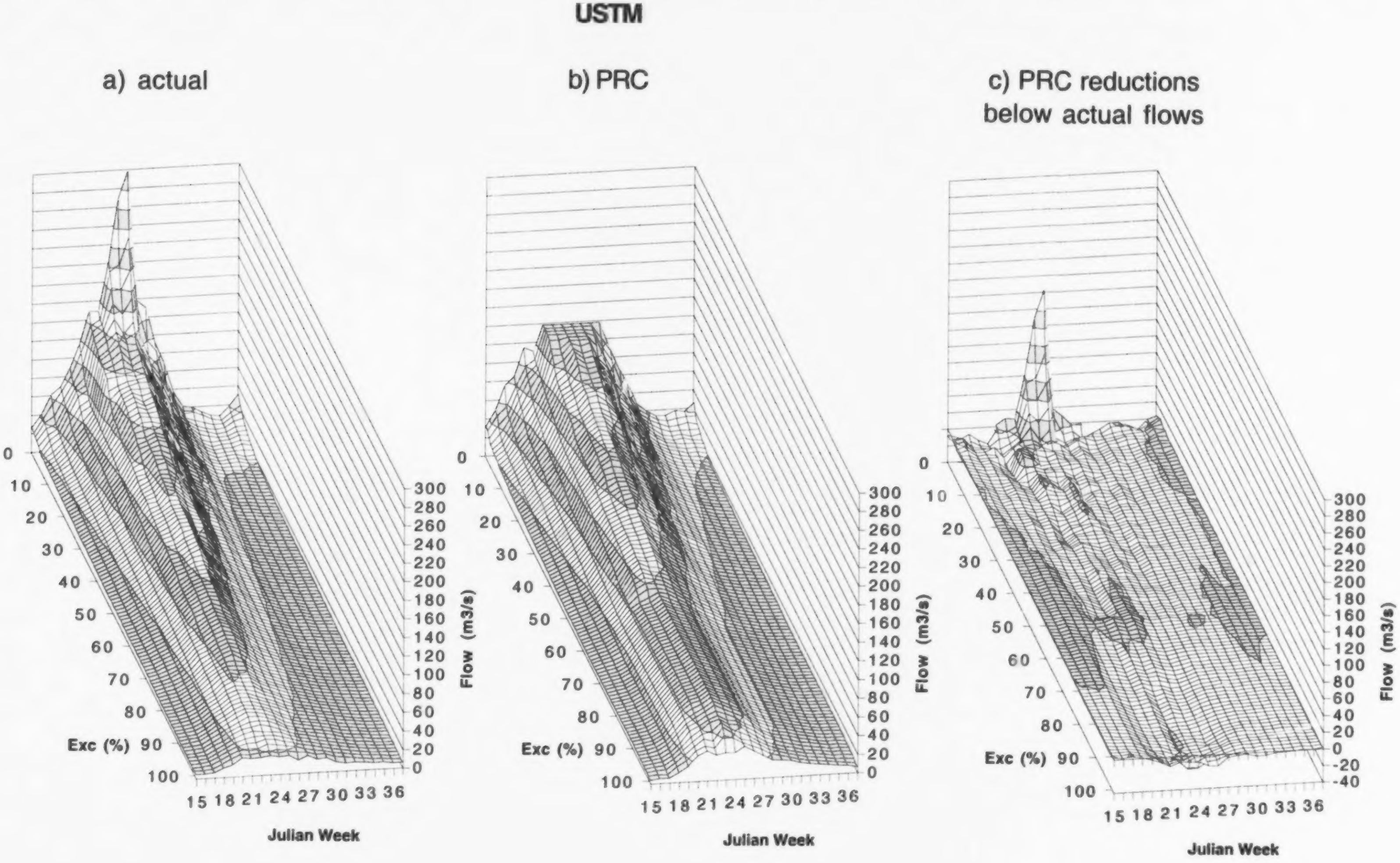
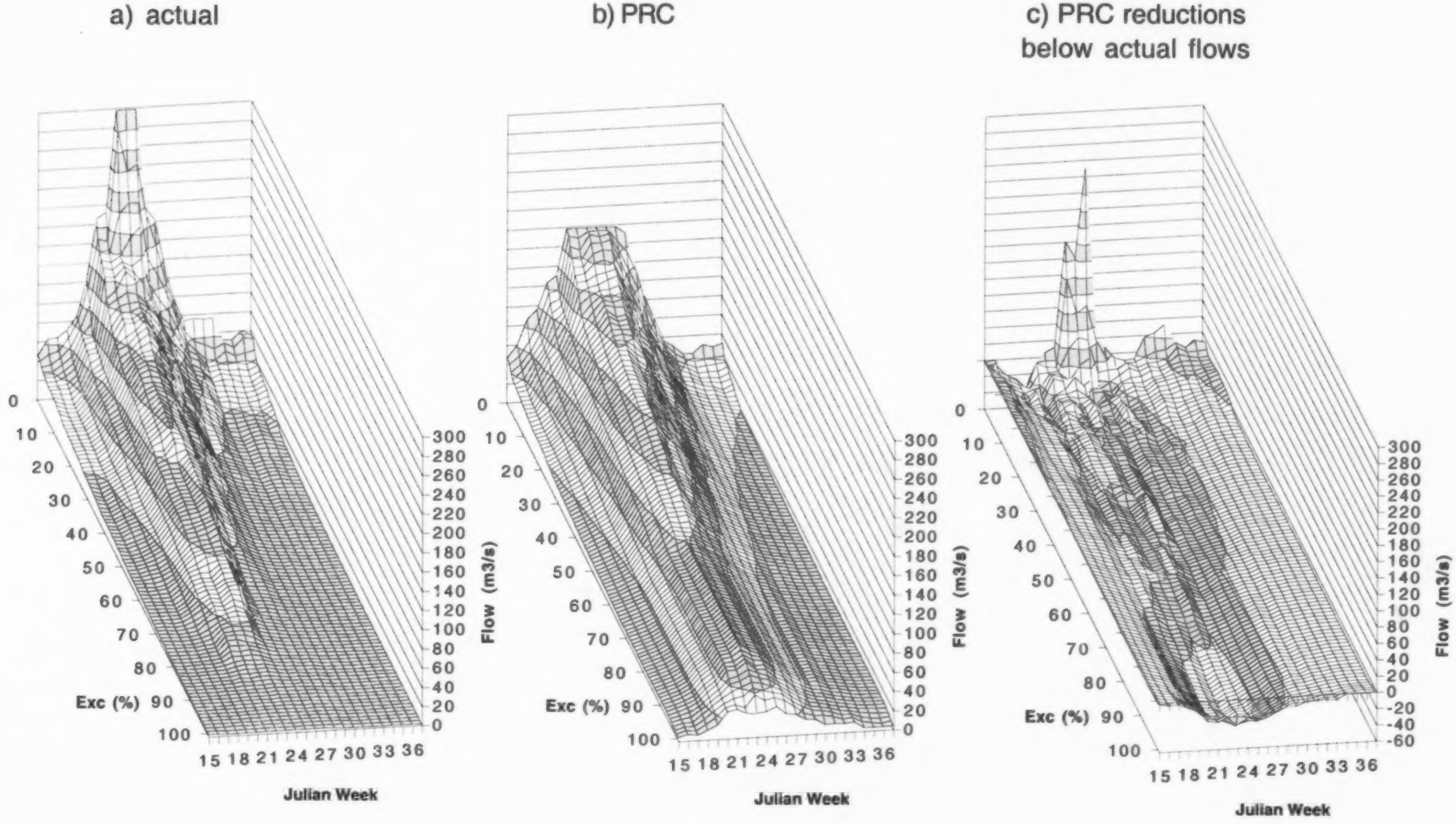


Figure 24. Exceedences of actual flows, PRC flows, and PRC reductions to actual flows during the cottonwood growing seaso (Julian weeks 15-37) of 1912-1995 along the upper St. Mary River (at US / Canada border).

Figure 25. Exceedences of actual flows, PRC flows, and PRC reductions to actual flows during the cottonwood growing season (Julian weeks 15-37) of 1912-1995 along the lower St. Mary River (at Lethbridge).

LSTM



a) actual

b) PRC

c) PRC reductions below actual flows

Figure 26. Ranges of naturalized flow affected by each PRC criterion for each test reach.

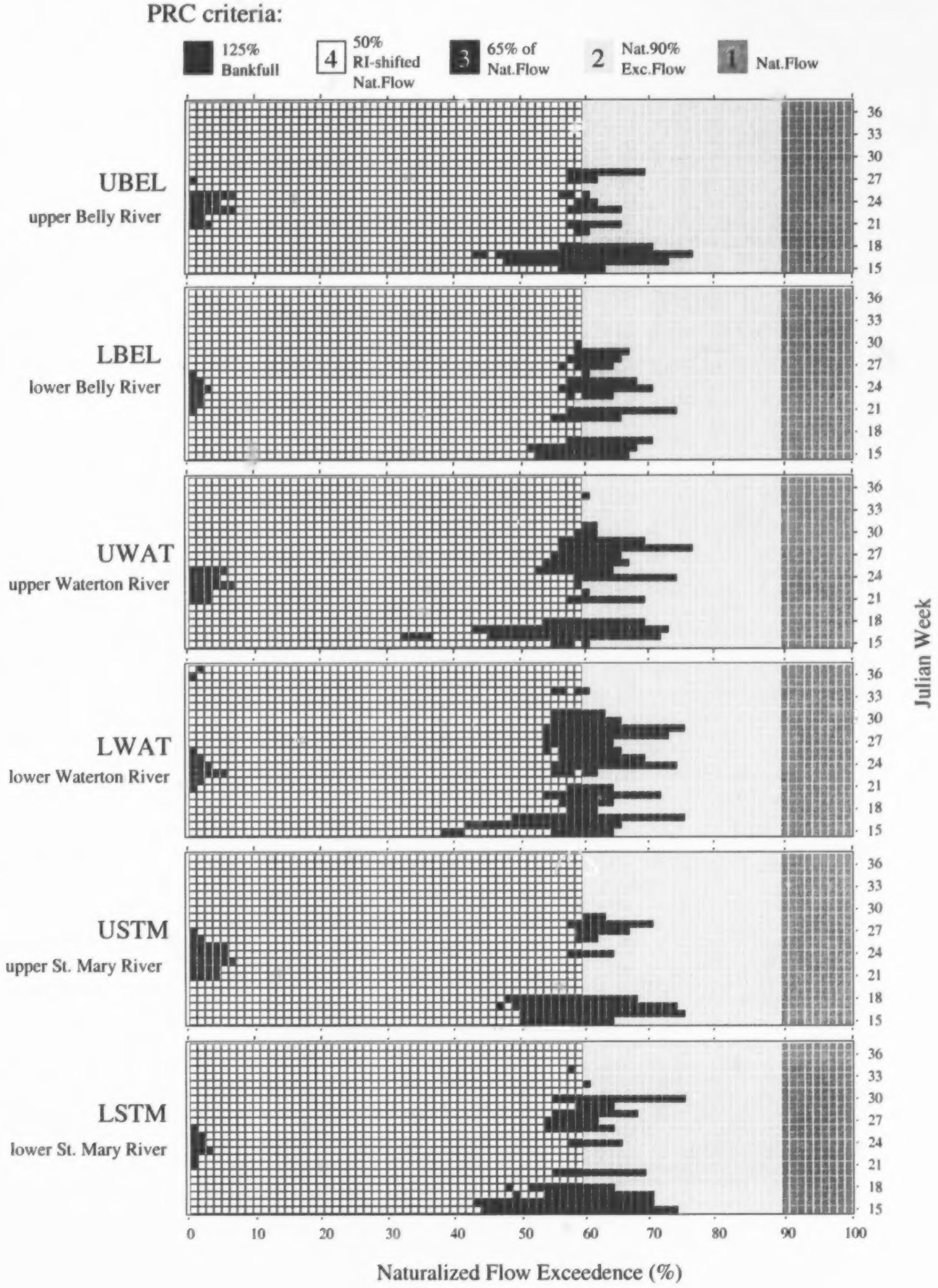


Figure 27. a) Average change from naturalized to actual weekly flows for each 1% exceedence interval during the growing season (Julian weeks 15-37) for a series of flow-regulated years, and b) summary of changes to flows between 90 and 100% naturalized exceedence (shaded areas), corresponding with flows affected by PRC criterion 1 along each test reach (UBEL / LBEL = upper / lower Belly River, UWAT / LWAT = upper / lower Waterton River, USTM / LSTM = upper / lower St. Mary River).

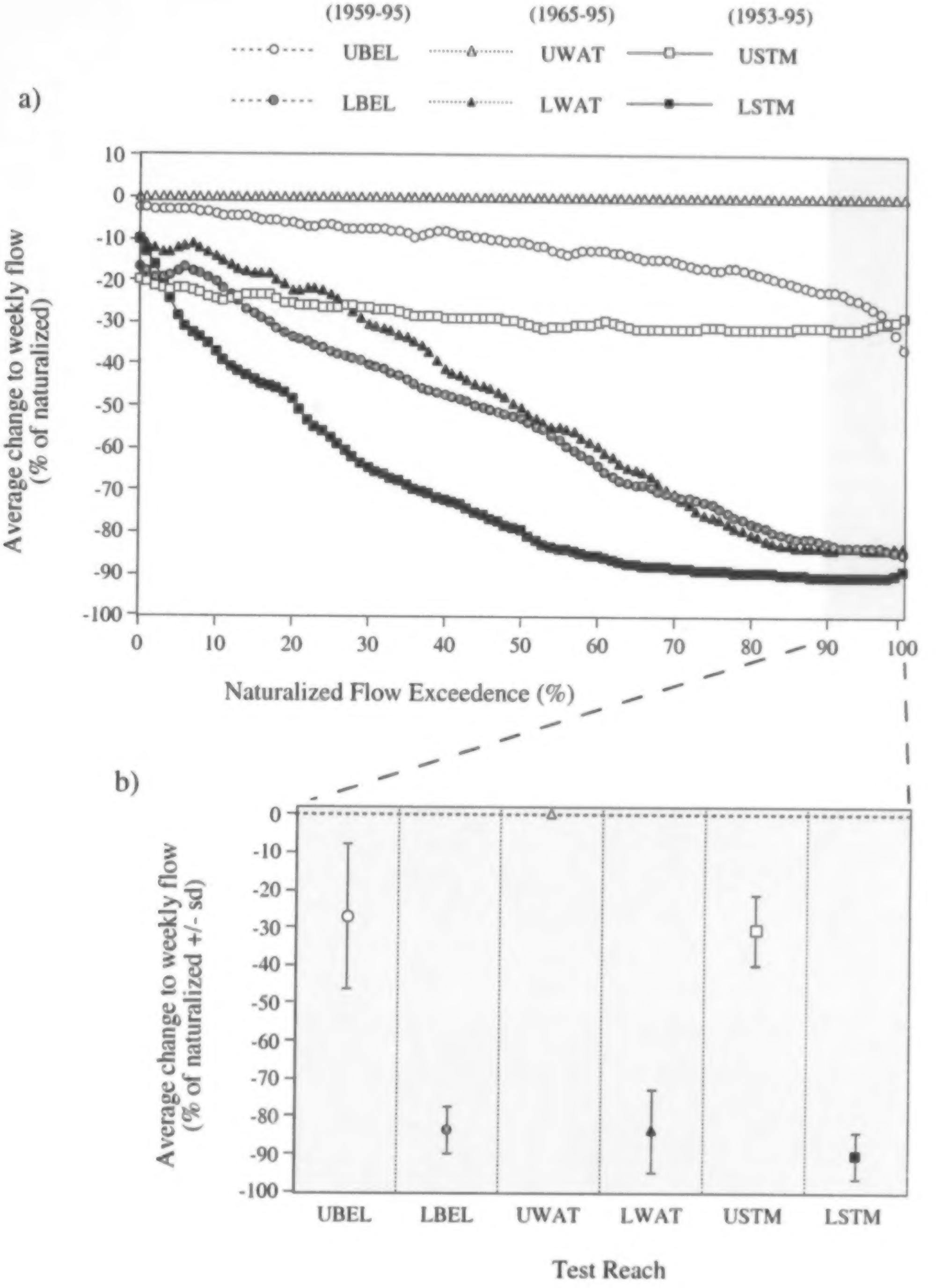


Figure 28. a) Average actual weekly flows relative to naturalized 90% exceedence flows for each 1% exceedence interval during the growing season (Julian weeks 15-37) for a series of flow-regulated years, and b) averages of actual weekly flows relative to naturalized 90% Exc. flows, across the 1% intervals between 60 and 90% naturalized exceedence (shaded areas), corresponding with flows affected by PRC criterion 2 along each test reach (refer to Figure 27 for abbreviations).

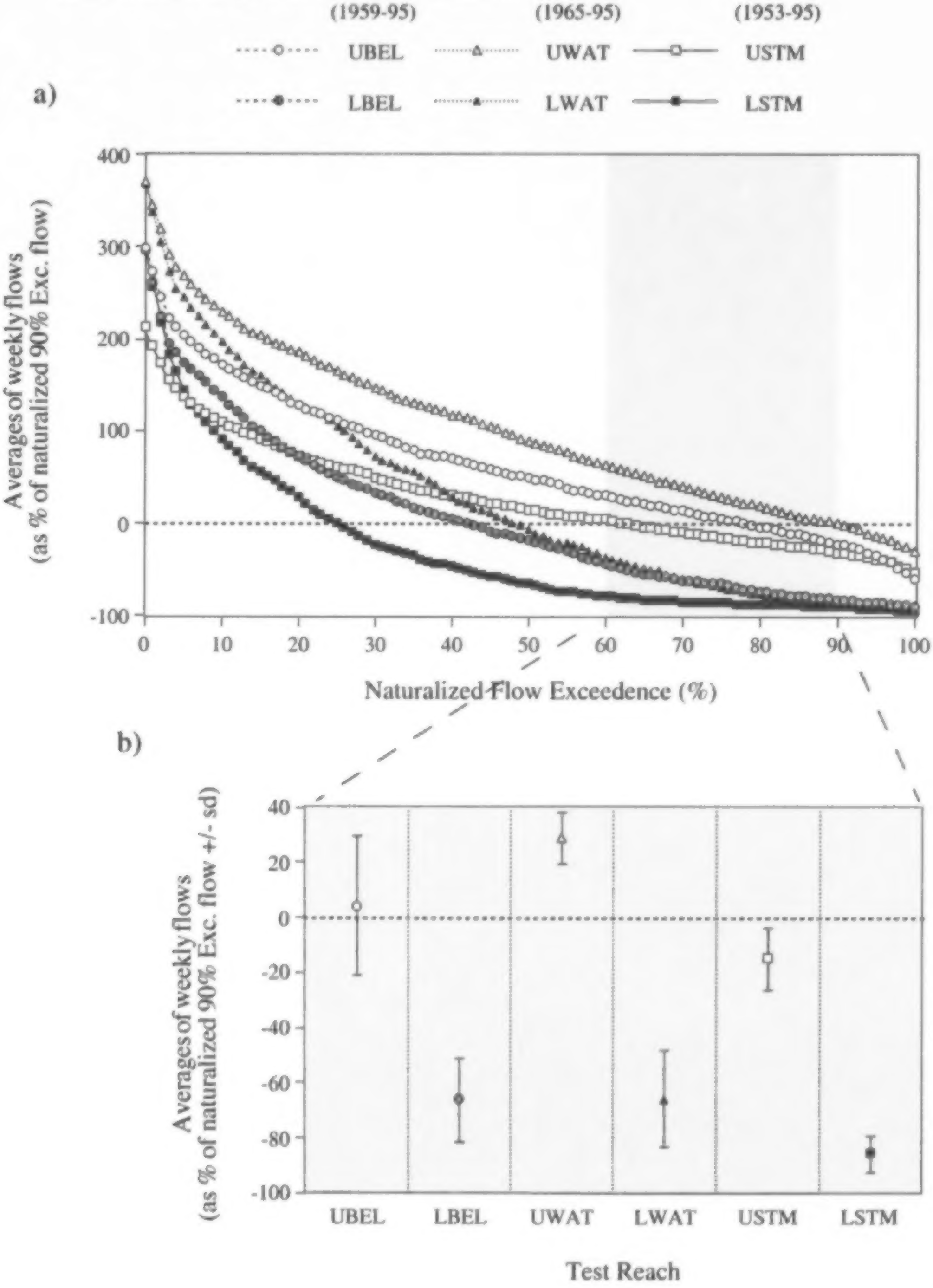


Figure 29. a) Average change from naturalized to actual weekly flows for each 1% exceedence interval during the growing season (Julian weeks 15-37) for a series of flow-regulated years, and b) summary of changes to flows between 50 and 70% naturalized exceedence (shaded areas), corresponding with flows affected by PRC criterion 3 along each test reach (refer to Figure 27 for abbreviations).

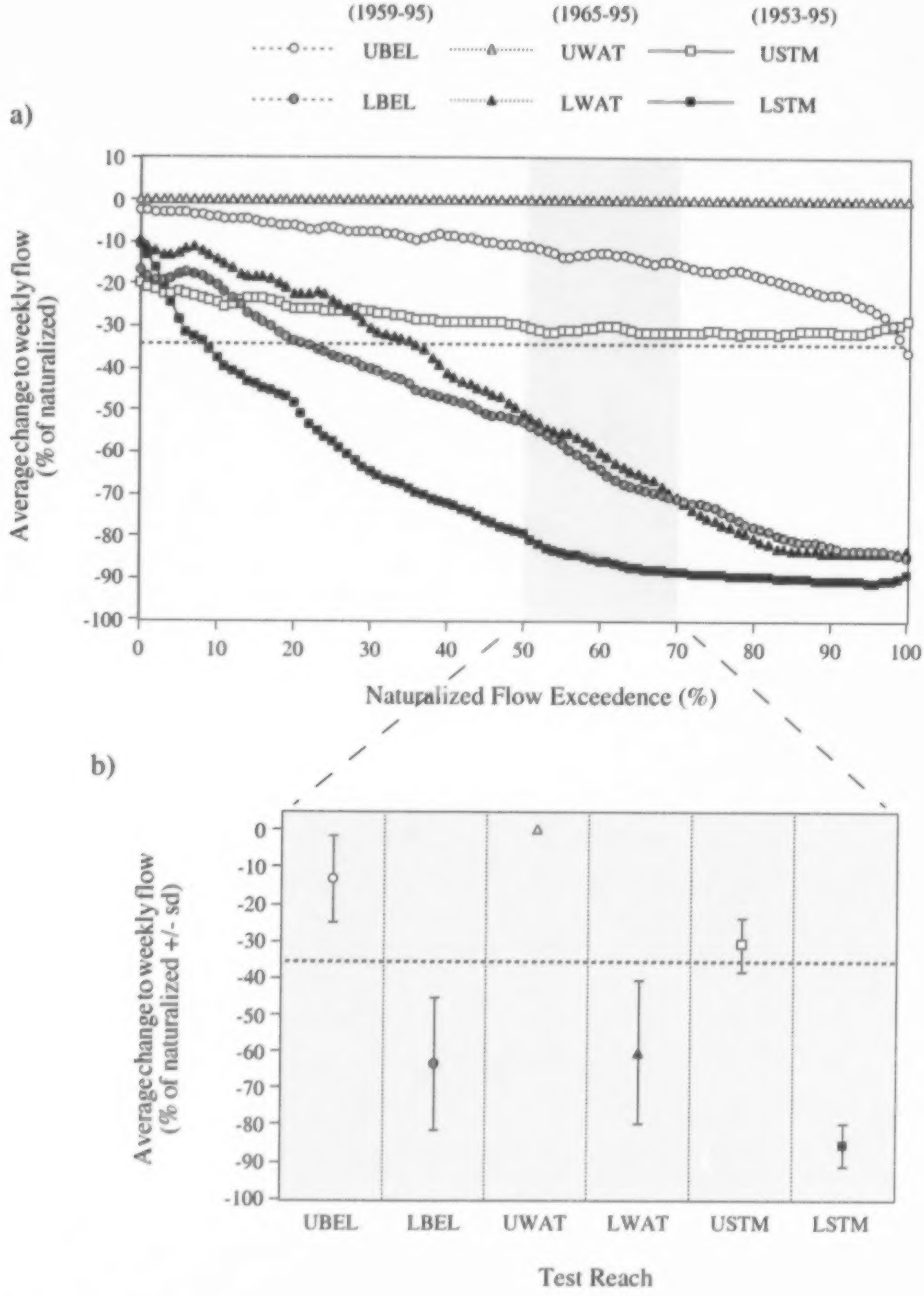


Figure 30. a) Average return interval shifts from actual to naturalized weekly flows for each 1% exceedence interval during the growing season (Julian weeks 15-37) for a series of flow-regulated years, and b) summary of changes to return interval shifts of flows between 5 and 60% naturalized exceedence (shaded areas), corresponding with flows affected by PRC criterion 4 along each test reach (refer to Figure 27 for abbreviations).

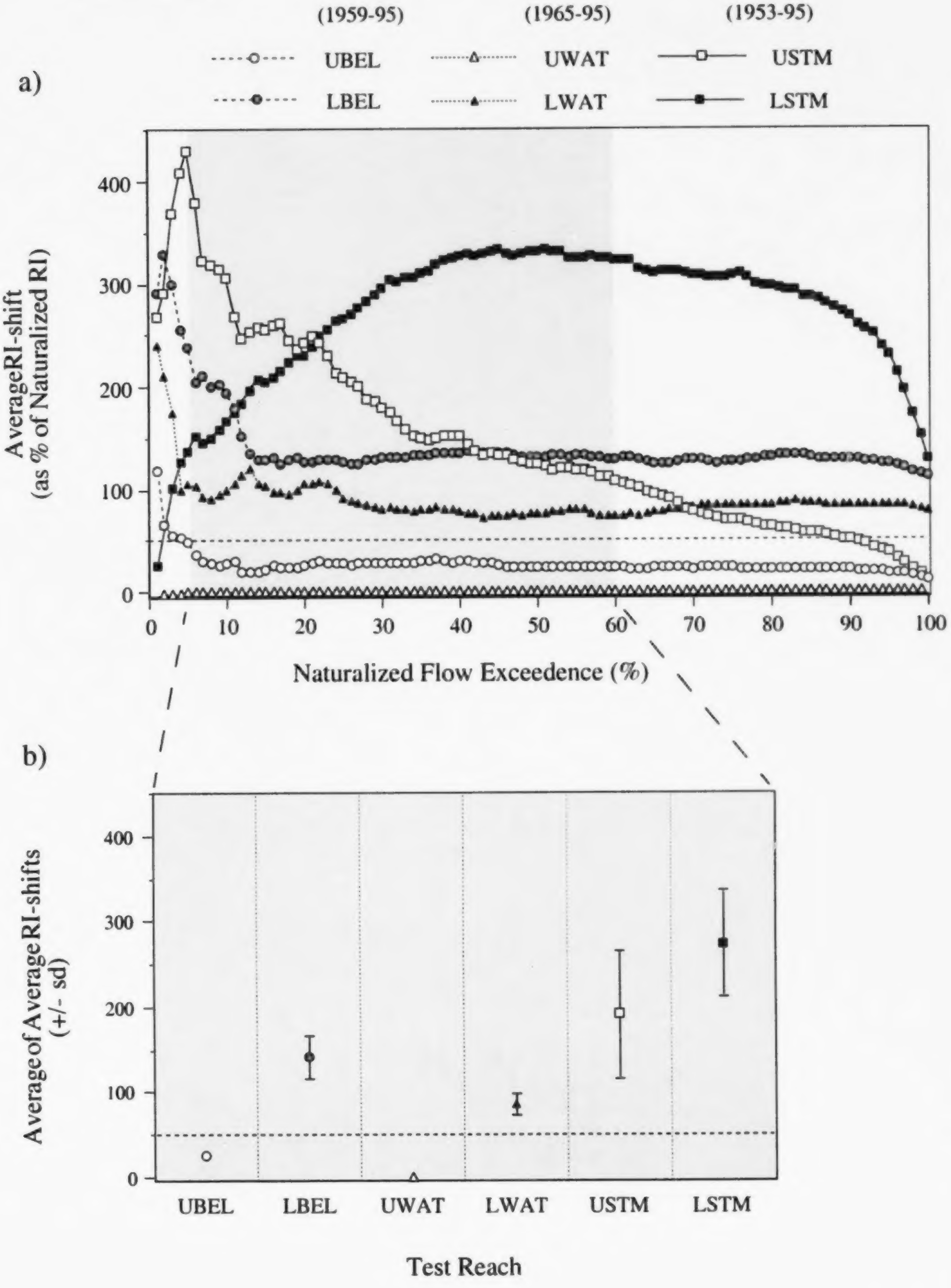
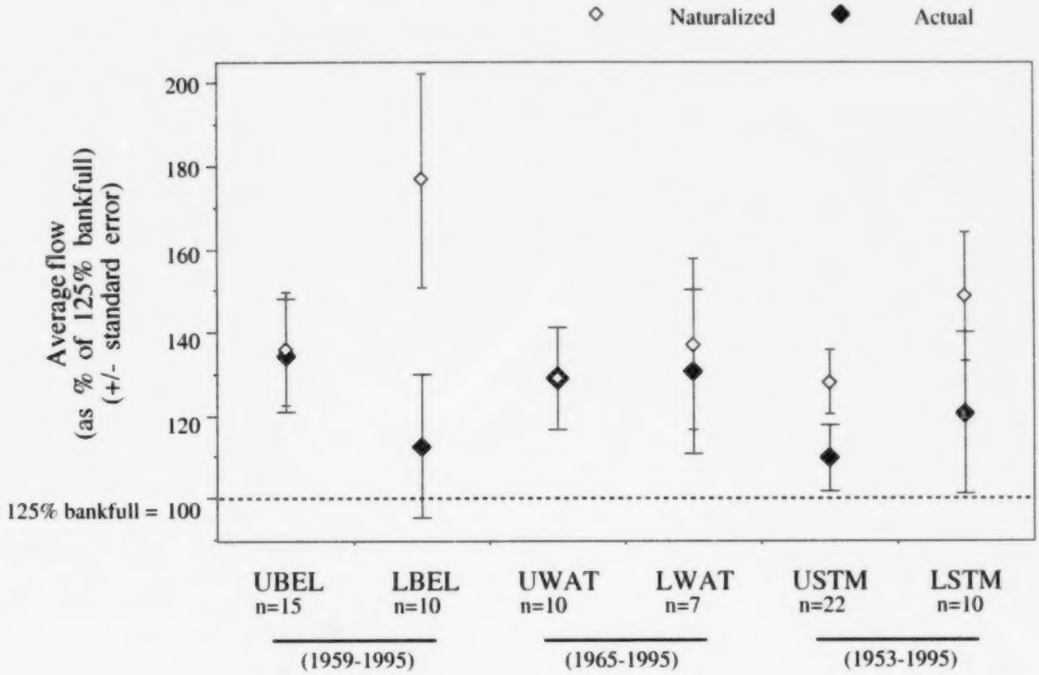


Figure 31. Comparison of naturalized weekly flows greater than 125% bankfull with their corresponding actual weekly flows (recorded during flow-regulated years for each test reach). The number of flows incorporated into each set of averages is indicated under the x-axis labels. (UBEL / LBEL = upper / lower Belly River, UWAT / LWAT = upper / lower Waterton River, USTM / LSTM = upper / lower St. Mary River)



Appendix 1. Naturalized weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 1 of 6)

UBEL = Belly River at Mountain View (Station 05AD005)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	5.81	6.02	6.61	7.52	11.86	25.37	24.14	21.29	17.27	23.40	20.06	21.33	17.06	16.76	14.70	17.80	12.13	9.76	7.69	6.62	6.29	5.53	5.63
1913	4.30	8.05	11.33	7.46	9.26	14.14	29.76	55.17	47.04	39.97	29.86	38.10	24.74	19.26	12.17	14.81	13.07	16.51	12.37	8.51	8.10	6.94	5.50
1914	4.24	10.03	12.46	17.34	17.34	27.57	26.86	25.79	23.73	28.14	24.56	18.16	21.04	15.13	12.86	9.90	9.48	7.56	7.96	8.67	6.09	4.69	4.64
1915	5.33	11.28	8.90	16.17	20.60	17.67	14.03	20.14	30.06	24.34	24.11	28.31	22.51	15.67	14.40	14.90	14.89	11.69	10.15	9.36	8.51	10.12	8.62
1916	6.35	7.55	7.62	13.39	21.96	11.11	15.44	17.41	28.06	40.04	62.37	49.47	45.06	43.81	29.79	19.97	14.83	15.81	14.70	11.81	10.73	15.44	9.00
1917	2.77	2.78	2.91	4.01	13.62	32.26	35.46	34.80	45.29	46.04	40.60	32.31	32.73	28.40	23.44	15.41	9.16	8.40	7.92	7.99	6.19	4.56	4.58
1918	7.05	8.31	10.13	23.40	22.74	21.91	11.40	13.93	28.31	41.59	27.47	18.09	12.60	13.17	11.73	9.74	9.00	8.30	9.09	6.98	7.02	6.33	5.95
1919	3.15	5.22	7.69	15.43	10.37	13.52	41.26	36.40	19.59	15.81	20.31	17.69	11.54	10.79	9.55	7.97	7.70	7.10	5.91	5.72	4.32	3.72	2.96
1920	1.96	2.07	3.27	4.34	12.33	24.26	25.96	15.87	27.79	45.31	43.80	29.37	37.27	29.40	26.66	18.46	14.59	11.19	10.16	7.19	6.37	5.03	6.76
1921	6.48	12.07	8.66	8.21	20.16	23.59	45.40	33.97	42.63	38.83	30.06	30.27	23.79	18.74	15.60	13.01	11.03	8.50	8.06	6.62	5.66	4.93	4.10
1922	2.05	3.19	5.11	12.20	11.40	30.74	37.61	36.20	45.56	37.69	33.17	25.17	24.43	24.53	14.23	10.63	9.83	8.71	6.76	6.34	6.06	5.27	4.05
1923	2.58	6.36	7.05	8.13	19.41	19.34	30.51	43.19	51.06	38.39	31.19	27.49	21.30	17.29	15.94	12.86	9.63	6.91	7.11	13.77	8.16	6.18	4.66
1924	2.99	3.31	3.56	9.79	17.46	33.09	22.87	20.46	33.03	38.64	32.06	23.46	26.06	16.86	12.16	10.84	10.01	10.87	10.63	8.59	7.45	5.84	5.05
1925	14.90	15.61	10.31	14.65	18.46	40.70	53.13	37.69	23.99	29.91	38.56	32.60	22.71	17.66	14.41	11.47	10.09	8.14	8.95	7.97	5.98	6.10	7.19
1926	4.44	15.94	11.16	16.16	9.79	8.93	8.63	6.96	8.78	8.28	14.56	13.09	10.28	8.99	6.84	5.82	5.36	4.70	4.31	4.28	6.77	13.87	11.40
1927	2.40	4.63	17.74	17.73	11.48	28.99	28.53	38.96	58.46	64.00	57.33	48.10	34.91	29.87	27.04	22.39	17.56	13.81	17.93	14.09	10.93	10.73	24.13
1928	3.45	2.96	8.17	13.80	27.66	37.21	48.84	34.84	22.01	24.81	37.51	47.66	42.07	25.47	20.34	17.43	14.60	10.53	8.52	7.13	8.49	7.20	5.47
1929	2.22	2.51	4.86	8.34	9.95	22.24	34.17	28.04	33.59	30.17	16.67	15.39	18.34	16.96	12.76	9.26	7.72	6.53	5.50	4.36	4.65	3.89	2.84
1930	13.84	14.71	25.16	27.43	18.94	19.84	29.30	27.57	29.94	25.59	21.33	18.66	16.03	15.47	12.93	9.77	8.09	7.43	6.31	4.93	4.37	3.92	4.69
1931	2.24	2.68	4.27	14.85	15.99	27.91	16.64	21.19	18.59	14.54	13.54	10.16	7.80	7.78	7.33	6.38	8.81	5.80	4.37	4.01	2.94	3.23	3.41
1932	5.04	5.78	5.88	8.00	26.83	34.50	34.77	21.43	27.27	31.20	30.39	27.10	19.86	13.50	11.56	9.90	8.50	6.92	6.22	6.74	5.03	3.51	3.28
1933	2.00	1.94	8.48	12.39	14.16	20.01	23.59	43.86	46.33	47.41	37.11	29.66	26.96	21.80	16.07	12.73	10.15	8.93	7.64	6.71	5.58	4.58	4.10
1934	14.96	21.66	37.17	27.43	35.97	33.93	26.10	31.27	50.66	37.20	21.31	19.37	17.53	13.69	11.61	9.63	8.77	6.73	5.72	4.99	4.28	3.98	3.67
1935	2.63	4.46	5.84	7.41	9.52	16.07	35.76	28.86	26.63	26.66	22.59	19.54	16.26	15.04	15.81	12.81	9.45	7.15	6.70	4.74	4.65	4.84	3.81
1936	4.57	12.62	11.60	12.93	25.16	33.17	18.61	30.37	22.87	19.27	15.30	14.06	10.42	8.74	7.87	7.04	5.76	4.81	5.20	4.10	3.07	3.69	3.26
1937	1.97	3.72	5.26	12.19	14.61	20.04	22.96	25.47	25.01	72.60	39.04	26.40	20.83	13.81	11.54	9.08	7.81	6.99	5.45	4.83	3.84	3.88	3.64
1938	3.23	13.81	10.25	16.71	14.53	27.86	40.19	47.36	35.36	29.69	34.59	27.83	24.63	18.54	14.23	11.27	8.11	6.04	5.31	4.63	4.36	4.39	3.73
1939	3.55	7.69	18.16	24.56	16.93	22.96	15.67	22.51	14.23	16.20	16.24	14.40	14.84	12.66	8.74	6.93	6.90	5.18	4.34	3.72	3.29	3.36	3.55
1940	2.21	5.91	7.61	11.81	19.03	22.53	23.63	22.33	17.90	20.36	17.29	12.49	10.28	8.61	7.52	9.35	8.00	5.03	4.17	3.64	3.39	3.49	3.53
1941	4.58	5.53	8.26	14.21	10.21	14.43	13.21	16.63	14.53	12.74	9.47	16.34	14.30	9.08	7.64	6.15	5.14	4.56	4.35	3.76	3.97	4.54	7.33
1942	6.26	10.88	14.21	8.37	21.60	17.20	31.77	25.00	48.87	24.36	16.56	36.40	25.47	17.44	12.73	10.80	9.77	9.08	7.40	6.61	5.49	4.99	5.53
1943	10.45	21.96	13.83	11.97	11.06	11.46	33.24	33.33	22.36	33.44	43.53	34.93	33.93	29.31	19.76	17.99	13.06	10.05	7.44	6.26	5.20	4.63	3.62
1944	2.37	2.25	2.95	7.55	9.39	18.76	17.50	18.14	17.26	16.11	16.76	18.11	13.67	8.52	7.09	6.45	5.55	4.67	6.72	5.63	4.83	4.44	3.78
1945	1.40	2.40	3.10	11.06	24.39	21.01	21.96	38.36	38.80	24.84	36.87	29.16	21.21	17.30	12.31	10.21	7.77	5.97	4.77	3.71	2.95	7.33	6.42
1946	6.11	10.48	21.99	19.56	21.23	29.59	27.90	36.10	33.99	28.21	28.33	19.73	20.61	18.20	13.07	9.95	7.73	5.93	4.92	4.56	4.37	4.36	4.62
1947	4.27	8.85	18.49	34.14	36.77	25.43	21.20	24.49	28.16	28.47	26.00	25.50	22.27	20.24	15.46	11.73	8.59	7.10	5.29	7.60	6.34	4.66	3.96
1948	1.76	7.22	9.86	11.30	14.21	18.01	58.81	52.23	59.19	48.27	59.37	35.80	24.16	14.97	13.93	13.23	19.51	10.13	7.44	6.41	5.69	4.61	3.82
1949	3.76	5.52	9.14	10.41	17.85	31.03	29.56	32.34	28.23	21.29	14.70	15.43	12.10	12.93	10.82	8.26	7.46	6.81	5.14	4.99	4.13	4.43	4.36
1950	2.51	4.50	5.01	4.16	8.79	28.00	25.76	30.60	40.44	44.50	53.20	41.76	43.73	31.04	22.46	19.37	15.13	11.04	9.48	7.93	6.87	6.52	5.21
1951	5.24	7.40	9.50	20.86	34.36	34.21	38.19	20.76	16.79	40.06	37.54	44.11	42.64	35.57	32.29	22.19	17.73	13.24	10.31	8.19	14.59	14.36	9.97
1952	3.69	10.66	17.04	21.63	13.99	23.19	25.59	21.13	22.69	22.96	18.67	17.69	18.76	14.03	13.03	11.01	9.78	13.63	11.48	7.28	5.96	4.96	4.36
1953	2.06	3.33	14.70	15.54	24.17	20.24	34.37	52.43	76.71	62.70	36.07	28.47	32.04	36.84	26.03	16.10	13.46	12.41	9.89	8.15	6.33	6.53	5.39
1954	3.16	5.27	3.95	3.87	16.16	43.79	50.03	33.00	31.34	35.81	33.24	40.54	40.63	39.14	31.03	19.06	14.81	12.29	10.54	9.89	13.89	8.98	8.50
1955	3.24	2.62	2.73	4.39	7.54	16.19	25.03	23.51	37.70	45.99	41.54	40.57	21.51	30.11	26.40	17.51	13.13	10.12	7.75	6.63	5.41	5.35	4.65
1956	2.72	7.70	9.08	5.36	7.85	23.12	53.80	45.89	39.39	31.67	30.23	22.57	23.93	24.21	20.40	17.37	12.50	9.87	8.96	7.31	7.64	5.71	4.64
1957	1.53	2.30	5.33	26.13	36.99	45.41	38.86	36.44	41.00	27.89	19.33	16.41	13.76	12.54	9.86	7.94	7.18	5.63	5.07	4.44	3.89	3.64	3.89
1958	3.35	5.90	4.79	9.12	31.23	30.23	37.57	30.13	34.11	31.03	26.06	22.27	14.80	15.10	12.04	11.03	9.84	7.57	6.87	5.98	5.22	3.81	4.39
1959	6.11	6.46	7.33	18.03	13.29	24.91	24.19	26.61	45.73	37.29	39.21	29.60	23.09	20.60	20.56	16.86	10.59	8.55	6.89	7.01	7.74	11.28	13.04
1960	10.78	7.08	5.55	5.93	15.23	25.59	13.07	21.76	34.41	27.60	23.97	23.86	20.37	17.34	15.61	11.65	11.09	9.73	7.16	5.71	4.31	5.40	4.70
1961	3.90	4.27	4.18	5.75	10.54	16.77	42.57	46.24	43.81	33.10	32.51	21.06	15.04	13.59	12.24	9.92	8.22	7.52	6.01	5.59	5.20	5.03	4.44
1962	4.53	11.88	17.79	10.11	10.74	19.87	25.53	26.80	20.39	29.14	27.39	21.79	14.27	12.63	10.17	10.65	9.97	8.21	6.88	5.46	5.08	4.91	6.22
1963	3.20	4.97	5.15	10.31	13.84	15.81	26.01	33.03	39.81	42.37	31.11	25.54	28.11	19.69	12.26	9.92	7.68	7.71	7.42	5.39	4.24	4.20	4.84
1964	2.42	2.80	2.96	11.66	14.23	23.30	31.63	26.24	117.20	75.91	40.73	38.71	30.14	26.90	20.00	13.31	11.08	8.90	7.56	6.18	5.37	6.37	5.43
1965	2.69	4.32	12.34	18.20	15.01	25.50	21.13	36.57	37.86	45.86	51.79	39.47	29.94	26.73	20.79	15.24	14.69	11.89	9.82	8.32	6.49	5.94	6.92
1966	8.42	7.45	7.02	10.77	29.80	15.41	23.63	46.10	41.47	33.21	27.87	24.01	22.44	21.46	16.84	12.09	9.95	8.72	6.92	9.24	8.43	6.60	5.65
1967	2.50	2.53	2.39	3.16	10.41	22.39	49.87	44.74	42.61	41.26	48.96	44.03	37.27	26.53	20.79	15.19	12.51	10.24	9.27	8.01	6.15	5.61	4.85
1968	2.79	3.06	2.98	8.76	10.78	14.86	31.50	30.39	35.69	31.13	26.74	24.23	20.66	22.30	14.17	12.04	10.59	8.93	9.69	9.36	7.35	7.70	7.32
1969	7.50	9.45	15.80	10.59	19.41	26.33	22.81	28.41	39.33	21.89	25.27	45.53	24.31	17.61	12.13	10.42	8.42	6.75	6.08	5.88	4.96	4.15	3.64
1970	2.46	1.89	1.76	5.68	19.36	27.26	41.14	33.07	51.16	62.60	50.53	31.99	19.24	15.71	12.86	9.80	8.76	7.94	5.97	4.93	4.45	4.22	4.06
1971	3.19	4.41	12.71	19.30	33.37	27.63	25.60	42.97	39.97	32.30	29.26	32.46	26.01	22.17	22.11	18.97	15.11	13.59	9.66	7.18	6.89	5.77	4.38
1972	6.84	5.27	5.78	10.56	10.18	37.91	42.04	49.80	58.69	47.83	31.47	25.84	23.96	23.30	23.59	24.46	19.81	16.00	12.86	11.30	9.93	7.31	7.13
1973	2.67	3.43	4.49	5.62	9.98	30.83	26.11	19.09	28.16	25.47	17.40	20.11	13.69	12.07	10.21	8.13	7.59	7.00	6.07	4.81	4.19	4.11	4.10
1974	3.19	5.36	14.08	17.96	25.31	13.27	17.57	29.40	33.83	49.43	58.86	46.30	31.44	24.77	25.00	19.64	15.84	12.80	8.84	7.76	7.47	5.55	5.86
1975	1.18	1.33	3.29	4.77	16.29	32.09	20.54	33.40	53.61	46.19	136.10	49.67	55.67	48.61	25.47	19.24	16.74	12.07	10.28	12.79	12.44	9.99	6.37
1976	8.50	8.96	6.20	11.52	34.76	32.79	26.17	23.54	16.44	22.79	26.03	21.47	23.91	24.73	19.93	17.03	13.39	14.99	13.27	10.90	9.20	7.48	5.49
1977	3.97	3.93	8.58	15.29	13.79	12.23	9.44	10.50	17.54	13.00	11.19	9.86	7.37	6.19	6.47	8.25	7.16	6.11	9.51	8.12	8.42	9.33	7.25
1978	4.30	3.99	5.85	16.31	15.80	23.93	27.90	21.41	41.76	28.90	25.06	27.81	26.89	19.56	25.31	16.63	12.13	10.17	9.50	12.67	9.01	8.23	12.41
1979	2.84	3.58	5.01	12.82	14.01	24.44	41.50	31.09	32.90	24.49	21.33	19.64	17.11	13.90	10.29	8.87	7.15	6.28	5.48	6.65	5.49	4.94	3.95
1980	1.72	8.49	23.09	34.20	24.03	18.37	40.01	36.74	21.63	36.27	27.00	15.59	14.41	13.90	11.19	9.61	8.20	6.66	6.92	9.03	6.08	6.01	6.15
1981	3.26	4.81	16.92	24.64	14.20	25.84	54.09	36.54	27.70	22.49	21.67	23.77	24.69	17.10	15.33	14.63	10.46	8.93	8.68	6.80	5.99	4.78	4.10
1982	0.98	1.77	4.12	6.83	6.89	15.92	27.89	19.96	27.70	40.27	40.53	35.76	26.27	19.19	16.21	13.57	11.35	9.69	8.00	6.90	5.21	4.83	4.63
1983	2.00	3.24	9.68	7.22	10.04	10.29	29.09	35.16	25.07	23.29	19.00	18.23	16.17	18.17	16.33	11.80	9.61	9.16	7.49	5.50	4.79	4.52	3.31
1984	1.74	7.56	9.72	5.49	5.86	17.18	21.27	26.71	19.51	19.36	26.36	26.40	18.26	14.21	12.13	10.28	11.73	8.99	7.22	5.72	4.32	3.93	5.75
1985	7.10	11.28	8.07	22.29	15.60	18.20	37.64	28.30	30.66	23.60	20.71	14.20	15.10	12.91	9.22	7.78	6.62	6.56	11.89	8.92	6.54	6.40	14.66
1986	8.16	7.02	15.99	11.35	12.09	12.53	26.80	49.01	28.81	22.03	16.90	15.30	12.47	9.59	8.62	7.73	6.04	6.04	5.44	4.21	4.31	4.48	6.02
1987	6.72	12.78	14.14	27.14	27.26	21.80	16.03	26.33	18.86	18.31	15.46	10.90	10.50	8.24	16.76	24.21	12.06	8.57	9.26	9.04	8.66	6.60	5.37
1988	7.62	14.00	10.84	9.80	16.77	25.71	20.74	21.44	22.03	16.99	17.53	15.16	10.35	7.88	5.97	5.61	5.42	4.36	4.23	3.90	3.66	3.31	2.91
1989	4.46	11.24	13.84	13.11	32.30	18.85	14.13	17.05	35.56	44.11	21.96	20.41	16.51	15.95	15.04	11.38	8.97	7.46	6.68	10.75	16.70	11.54	9.99
1990	6.79	12.70	19.16	13.39	19.39	14.44	21.37	31.41	20.97	23.03	28.38	32.12	24.05	19.85	15.65	17.59	13.11	9.96	8.55	7.90	5.57	4.93	4.47
1991	8.17	6.70	13.46	9.69	13.70	42.32	46.21	33.39	36.63	33.78	49.43	36.82	34.41	23.45	20.58	15.44	12.87	11.38	9.16	8.12	5.89	4.96	4.27
1992	4.18	6.26	7.09	16.70	16.51	9.70	12.74	14.43	12.86	15.73	17.60	14.22	14.67	13.04	10.42	8.70	7.73	6.39	5.34	5.56	5.69	4.77	4.37
1993	5.16	5.43	6.50	7.79	15.06	31.41	23.72	20.51	15.44	20.86	23.02	15.52	20.91	22.28	18.10	20.24	15.29	10.76	12.09	11.47	11.21	11.25	10.36
1994	4.73	11.69	16.43	10.75	24.55	23.69	23.96	23.60	20.42	18.03	15.46	17.14	13.18	10.71	9.82	9.31	7.73	6.46	5.24	4.18	3.44	3.22	2.73
1995	4.17	4.33	5.58	8.72	23.56	31.77	25.08	41.40	90.05	52.60	50.68	41.92	36.63	30.62	23.67	22.28	14.84	13.44	10.25	8.21	7.10	6.73	5.74

Appendix 1. Naturalized weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 2 of 6)

LBEL = Belly River at Standoff & Glenwood (Stations 05AD002 & 05AD041)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	9.22	8.81	8.17	8.13	11.04	34.19	37.40	26.21	22.07	23.79	24.53	26.26	22.76	16.87	17.89	20.07	15.17	11.31	8.35	7.26	6.12	4.95	5.04
1913	14.82	16.94	15.01	10.85	11.33	17.93	29.59	65.54	51.17	41.91	29.57	37.29	26.53	20.29	13.56	16.70	15.67	16.73	13.54	9.53	8.26	7.65	5.94
1914	6.37	14.09	16.14	21.30	19.01	26.77	27.84	24.04	27.46	26.29	26.37	19.66	21.57	16.17	14.69	12.20	10.15	8.30	8.54	11.16	6.67	5.48	4.63
1915	5.86	10.79	9.55	16.66	21.01	25.14	14.49	16.00	46.20	40.11	36.01	46.86	30.03	16.06	15.29	26.37	23.39	13.30	11.83	26.79	9.13	19.90	10.37
1916	8.84	8.97	8.24	14.37	24.49	12.46	20.39	29.91	31.93	43.64	68.61	62.23	57.59	43.84	29.76	19.64	14.71	15.56	14.11	12.11	10.54	15.16	9.96
1917	11.53	6.85	8.96	9.73	16.64	33.70	36.97	45.54	44.24	55.61	46.59	34.00	32.84	29.04	22.67	16.10	11.17	8.52	7.44	7.84	5.97	4.53	4.19
1918	8.43	8.23	10.90	25.00	22.01	20.34	13.10	15.26	24.91	45.76	27.67	18.51	12.41	12.67	10.89	8.44	8.46	7.63	8.36	6.10	5.86	5.81	5.91
1919	3.30	3.76	8.23	16.03	10.40	14.40	36.17	33.50	20.93	16.64	21.59	18.97	12.41	10.56	8.96	6.81	5.83	5.92	5.37	4.71	4.44	4.00	2.75
1920	7.52	11.32	9.61	10.18	23.73	30.50	27.77	19.01	26.16	42.16	45.19	30.94	37.36	30.81	27.73	19.89	14.84	11.19	10.07	7.03	6.15	4.45	5.91
1921	8.32	13.04	9.62	8.14	24.39	23.53	51.10	37.27	46.76	40.84	30.94	31.46	25.33	19.61	15.00	12.90	10.81	8.26	7.99	6.73	5.26	4.67	4.38
1922	2.70	7.12	8.96	17.96	13.34	28.94	38.10	36.37	48.49	37.20	33.01	24.39	21.84	25.51	15.56	11.38	9.52	9.47	6.86	5.89	5.51	5.13	4.09
1923	4.13	6.77	6.83	9.07	17.71	20.83	30.97	42.37	52.39	42.67	36.91	30.61	23.84	18.54	16.43	13.24	9.67	7.17	7.57	13.96	8.49	6.71	4.71
1924	5.60	3.84	3.28	7.35	18.17	31.09	23.74	19.96	35.44	44.56	36.60	25.20	27.94	19.14	12.93	10.61	10.35	13.91	12.70	10.78	8.24	6.92	5.35
1925	18.29	19.94	17.69	17.94	19.17	41.21	49.94	37.46	25.99	30.53	38.13	34.03	22.93	16.49	13.80	11.71	10.46	7.91	9.25	7.58	5.93	6.15	5.90
1926	2.78	18.14	12.54	17.04	11.72	8.19	8.27	5.53	7.48	8.23	14.25	13.79	10.78	9.08	6.59	5.76	4.47	5.23	4.74	4.44	6.23	15.01	14.29
1927	4.44	10.24	22.81	21.56	15.11	31.24	66.27	84.69	66.83	73.99	60.89	55.14	39.46	33.29	30.57	23.17	19.23	15.51	19.33	20.16	12.54	12.46	33.21
1928	5.98	5.86	8.14	15.56	25.13	39.16	46.11	37.87	23.53	23.76	45.21	52.98	68.86	36.04	29.14	20.50	17.89	11.54	8.65	8.59	10.29	8.09	6.13
1929	4.52	4.71	7.60	12.20	16.01	27.59	40.13	28.76	45.16	39.23	19.89	15.83	17.49	19.86	13.64	9.14	7.72	6.13	5.95	5.05	4.46	4.57	3.55
1930	12.27	16.34	22.97	29.86	24.87	23.16	33.50	31.87	29.70	27.24	22.99	19.61	15.80	14.63	13.99	11.00	7.22	6.30	6.58	5.45	5.08	4.45	5.64
1931	2.51	2.73	3.61	10.24	15.27	28.90	18.74	22.94	20.56	16.74	15.77	12.40	8.45	8.43	7.94	6.91	9.54	8.28	4.73	4.34	3.18	3.49	3.69
1932	6.08	7.73	7.84	10.15	27.96	34.51	34.74	23.16	28.34	31.73	31.03	28.19	21.52	14.62	12.52	10.73	9.21	7.49	6.74	7.30	5.45	3.80	3.56
1933	3.02	3.10	10.65	14.64	16.37	21.87	25.10	42.20	44.18	45.04	36.69	30.41	29.22	23.62	17.41	13.79	10.99	9.68	8.27	7.27	6.05	4.98	4.44
1934	15.23	23.37	36.74	28.48	35.74	34.04	27.32	31.79	47.62	36.76	23.05	21.28	18.99	14.83	12.58	10.43	9.50	7.29	6.19	5.40	4.63	4.31	3.97
1935	2.70	6.22	7.79	9.51	11.74	18.20	35.57	29.72	27.78	27.81	24.21	21.44	17.62	16.29	17.13	13.88	10.24	7.74	7.26	5.14	3.73	3.84	3.73
1936	7.46	8.45	12.06	9.73	23.29	32.26	14.41	19.59	17.23	15.80	9.77	6.98	11.29	9.46	8.53	7.62	6.23	5.21	5.63	4.44	3.32	3.99	3.53
1937	4.72	5.35	7.14	14.44	16.80	21.90	24.54	26.77	26.36	64.37	38.28	27.58	22.57	14.96	12.50	9.83	8.46	7.57	5.90	5.23	4.15	4.20	3.94
1938	7.33	16.03	12.49	18.80	16.73	28.85	39.22	45.00	35.23	30.43	34.59	28.83	26.69	20.09	15.42	12.21	8.78	6.54	5.75	5.01	4.72	4.75	4.04
1939	4.44	9.82	20.16	25.96	19.01	24.54	17.82	24.14	16.44	18.32	18.36	16.60	16.08	13.71	9.47	7.50	7.57	5.61	4.70	4.03	3.57	3.64	3.84
1940	2.94	7.87	9.73	14.06	20.97	24.15	25.14	23.97	19.92	22.19	19.35	14.73	11.14	9.33	8.14	10.12	8.66	5.45	4.51	3.94	3.67	3.78	3.83
1941	4.17	7.45	10.42	16.42	12.45	16.63	15.44	16.73	16.73	14.98	11.69	18.45	15.49	9.84	6.27	6.66	5.56	4.93	4.71	4.07	4.30	4.91	7.94
1942	6.96	13.13	16.42	10.53	23.32	19.26	32.21	26.35	46.20	25.79	18.66	36.10	27.60	18.90	13.79	11.70	10.56	9.83	8.01	7.16	5.95	5.40	5.99
1943	12.77	23.64	16.05	14.22	13.31	13.71	33.46	33.53	24.00	33.62	41.94	34.87	36.77	31.76	21.41	19.49	14.15	10.89	8.06	6.78	5.63	5.01	3.92
1944	3.33	3.51	4.40	9.67	11.60	20.72	19.55	20.14	19.32	18.24	18.85	20.11	14.81	9.22	7.68	6.98	6.01	5.06	7.28	6.10	5.23	4.81	4.09
1945	2.10	3.71	4.58	13.31	25.81	22.78	23.64	37.72	38.08	26.21	36.49	29.98	22.98	18.74	13.34	11.06	8.42	6.47	5.17	4.02	3.20	7.94	6.95
1946	4.40	12.72	23.67	21.46	22.98	30.35	28.89	35.85	34.09	29.16	29.26	21.61	22.33	19.72	14.16	10.78	8.37	6.42	5.33	4.93	4.73	4.72	5.00
1947	7.08	11.04	20.47	34.21	36.41	26.73	22.95	25.90	29.11	29.38	27.23	26.79	24.13	21.93	16.75	12.71	9.30	7.69	5.72	8.44	6.87	5.07	4.28
1948	3.19	9.31	12.09	13.55	16.42	20.02	53.95	48.85	54.25	45.73	54.38	35.60	26.18	16.22	15.09	14.33	21.14	10.97	8.06	6.95	6.16	5.00	4.14
1949	3.09	4.19	7.90	10.37	13.20	30.71	33.07	33.91	27.80	23.36	16.79	15.54	12.23	13.11	11.61	8.01	6.80	6.23	4.98	4.48	3.69	3.95	4.47
1950	8.29	12.86	8.73	6.93	10.32	29.46	26.14	30.80	40.19	41.83	52.77	39.63	43.46	32.57	24.11	20.19	16.20	13.06	10.41	9.10	7.55	6.92	6.12
1951	9.91	11.14	11.97	47.81	40.40	55.23	44.99	25.70	33.46	44.16	43.34	92.33	53.79	51.07	36.71	24.99	19.69	15.44	12.59	9.92	26.36	21.79	14.20
1952	15.47	19.73	21.61	27.46	17.99	25.04	26.76	22.11	21.19	25.74	18.70	18.40	19.61	15.36	15.13	12.51	10.29	14.77	14.29	8.76	7.15	6.39	5.66
1953	4.15	6.54	24.83	25.99	26.43	17.40	34.44	61.54	175.00	66.73	47.71	34.50	36.69	38.50	30.06	19.84	17.44	15.14	12.09	10.52	7.97	7.56	6.82
1954	9.13	9.65	7.18	9.39	20.01	42.66	55.03	36.34	33.97	36.47	30.87	39.96	41.10	40.66	32.10	23.54	16.30	13.34	11.17	11.78	17.29	11.80	8.42
1955	12.64	5.75	6.03	8.48	9.86	41.70	41.37	27.61	37.64	45.20	37.89	42.90	25.36	35.74	29.83	20.50	14.21	10.49	7.95	7.01	6.49	5.01	5.10
1956	4.16	9.12	12.25	8.44	12.73	22.21	55.93	47.23	44.39	27.10	31.56	22.61	31.29	26.66	23.36	19.14	14.87	10.48	10.15	7.72	8.07	7.26	5.76
1957	3.12	3.79	5.97	27.04	38.33	44.49	40.44	34.29	40.67	29.06	18.49	15.84	13.64	12.13	9.80	7.53	7.01	5.89	5.17	4.78	4.59	3.62	4.04
1958	7.79	7.92	7.15	9.65	31.73	33.51	38.63	30.80	33.10	35.79	26.03	24.63	18.03	17.66	13.59	12.73	11.13	8.41	7.07	6.20	6.36	4.67	4.61
1959	7.55	9.36	9.48	20.99	15.64	26.66	27.87	27.07	48.70	37.89	38.54	33.13	25.74	20.23	21.10	17.27	11.23	9.28	7.66	9.21	8.12	10.26	14.94
1960	12.10	8.61	7.15	10.69	15.61	28.14	15.33	19.01	33.53	23.61	22.40	20.84	20.67	15.10	15.26	12.30	9.74	10.70	7.15	6.20	5.23	4.39	5.89
1961	4.84	5.17	5.48	5.34	11.47	20.03	44.19	51.63	43.93	31.87	31.79	19.89	15.08	14.80	13.29	10.44	8.55	8.27	6.64	5.51	5.07	5.49	5.79
1962	6.94	12.18	18.74	10.99	10.29	19.21	25.86	26.00	18.93	27.86	27.19	22.03	15.83	12.97	10.96	9.89	10.83	8.68	6.95	6.15	5.09	5.73	6.30
1963	3.88	4.70	4.94	8.10	11.83	12.71	21.11	29.46	34.97	41.96	34.77	29.21	37.73	27.46	15.17	10.49	8.18	7.62	8.10	8.18	6.88	7.19	6.91
1964	5.18	3.74	4.41	22.30	21.63	22.39	33.27	23.56	85.19	101.50	49.80	41.14	33.24	28.66	22.29	14.07	13.29	9.35	8.25	6.80	5.52	7.18	6.84
1965	8.47	8.91	14.06	16.09	11.64	24.81	21.69	34.00	38.01	43.94	59.10	45.03	29.10	27.80	20.50	15.91	15.23	12.94	10.91	9.09	7.71	7.20	8.54
1966	10.43	9.60	8.68	9.74	31.46	19.13	17.46	40.61	51.26	35.49	27.41	22.94	23.57	22.43	18.24	14.40	11.54	9.91	7.67	11.37	9.45	7.16	8.35
1967	4.68	4.18	6.10	5.97	31.71	34.14	59.46	52.94	52.96	51.39	55.09	42.77	36.10	25.97	21.64	15.80	13.76	11.27	9.41	8.25	6.38	6.01	5.95
1968	4.53	5.10	4.62	7.49	12.37	14.10	28.60	32.24	35.79	32.37	25.23	23.43	20.77	26.06	17.93	13.89	11.96	10.25	10.96	12.99	8.90	8.93	8.02
1969	10.35	11.76	19.69	13.81	20.03	30.63	22.63	29.89	41.00	23.99	22.61	63.43	32.80	20.13	13.10	11.99	8.57	5.40	5.80	5.37	8.60	3.96	3.58
1970	4.61	3.73	3.55	7.60	24.93	29.16	42.43	34.49	49.00	70.16	57.57	33.57	18.13	13.96	11.11	8.50	7.70	7.18	5.97	4.97	4.67	4.84	5.77
1971	4.66	5.43	12.61	16.81	33.01	30.01	22.26	40.34	37.90	31.64	24.84	31.86	28.16	23.44	22.21	21.10	15.91	14.80	9.47	6.04	7.20	7.41	5.25
1972	9.53	7.51	7.65	11.21	11.84	33.93	43.20	44.71	54.43	45.73	29.61	23.07	24.64	22.99	27.31	25.24	20.99	15.96	12.86	11.21	9.71	8.66	8.79
1973	3.78	4.23	5.40	5.61	8.89	23.23	25.33	17.20	22.50	26.20	18.06	20.09	15.13	12.61	9.09	7.45	6.88	7.80	6.92	5.15	4.50	5.68	4.80
1974	5.09	6.18	14.92	22.56	25.24	14.76	13.83	30.01	34.20	43.40	55.86	44.11	31.84	25.24	24.60	20.20	15.70	13.73	12.60	7.74	7.18	6.33	6.08
1975	2.31	13.51	28.24	11.91	31.10	36.31	26.07	31.76	52.96	44.26	139.60	49.91	47.97	44.47	26.30	19.40	17.79	12.60	10.74	11.34	11.04	7.40	6.74
1976	9.53	11.55	8.24	12.21	34.64	35.36	27.34	24.29	15.36	22.31	26.71	25.16	25.29	28.73	23.34	18.20	15.34	19.74	14.99	11.10	9.83	8.18	6.53
1977	4.87	4.50	5.24	11.87	10.54	14.10	9.51	9.17	14.79	12.63	9.65	8.38	8.30	6.59	5.85	6.93	6.87	6.57	9.00	9.10	9.27	10.26	8.80
1978	5.48	5.75	6.30	17.50	20.30	27.00	30.49	23.20	41.04	31.46	25.74	27.67	31.91	22.10	30.04	18.33	13.54	10.58	9.50	14.43	10.82	8.44	14.30
1979	9.01	7.65	8.37	15.00	20.49	25.21	38.06	33.27	32.03	21.74	18.17	19.26	16.74	14.57	9.92	8.13	6.06	5.41	4.21	7.40	6.93	5.50	4.93
1980	3.24	6.90	16.59	32.31	23.91	14.97	39.16	54.49	29.94	36.90	31.97	20.89	14.91	12.11	11.57	9.60	6.35	6.51	7.10	9.79	7.28	5.90	6.99
1981	4.18	4.86	16.78	24.71	16.77	37.85	78.04	45.34	31.17	41.54	24.64	22.41	23.09	18.07	13.20	15.93	10.20	6.48	8.42	7.67	6.63	6.14	4.98
1982	8.76	5.95	5.00	7.64	9.10	15.93	28.99	22.24	29.94	40.93	42.46	39.70	33.63	25.20	17.77	16.31	13.11	8.69	9.16	8.20	7.74	6.35	5.48
1983	2.56	3.51	10.86	8.29	11.19	11.22	24.19	31.00	22.40	21.44	14.89	13.17	14.06	17.23	21.74	12.67	10.17	10.67	9.62	5.90	4.89	4.76	2.83
1984	2.33	5.65	10.39	5.60	4.44	12.61	18.80	22.11	19.89	17.01	26.89	26.87	16.21	13.73	11.08	9.20	12.43	11.02	9.98	6.47	4.13	3.54	5.76
1985	5.70	13.44	11.00	18.99	14.64	14.47	29.26	24.33	24.20	19.81	15.13	9.56	11.84	11.19	8.21	7.63	6.34	5.66	11.40	8.74	6.32	7.00	14.96
1986	7.24	5.93	13.51	10.80	12.67	12.16	24.61	50.73	27.16	20.87	15.06	12.13	13.51	11.96	9.14	7.82	6.75	6.02	6.39	5.26	4.99	5.74	7.09
1987	8.58	13.24	14.74	30.54	18.10	16.86	8.21	20.67	11.03	11.16	11.59	7.01	7.29	5.81	12.65	25.66	11.02	6.69	8.27	8.69	8.86	3.94	2.91
1988	8.73	14.69	14.69	11.56	15.47	26.57	19.39	20.51	19.19	16.34	14.49	16.49	13.63	9.79	7.28	5.99	5.81	5.08	4.71	4.09	3.79	3.02	2.58
1989	3.25	4.46	15.39	8.81	28.86	21.52	12.97	11.36	30.35	55.00	27.72	20.30	19.41	18.71	19.48	13.65	10.67	8.16	7.49	11.14	19.77	12.55	10.35
1990	6.33	10.81	18.42	12.50	19.29	13.83	20.83	36.70	22.42	27.64	29.11	34.61	26.74	20.80	17.56	18.14	15.14	12.68	11.36	11.02	9.18	4.75	4.17
1991	8.69	4.56	8.52	8.22	7.96	40.45	51.45	33.42	42.15	38.05	49.94	45.40	41.98	27.80	21.27	15.27	14.07	12.31	13.09	10.35	6.37	4.69	4.21
1992	3.56	6.98	7.89	11.92	15.88	13.31	11.33	11.38	11.19	15.47	19.27	14.29	19.67	19.80	16.33	10.25	10.31	8.98	5.91	6.46	6.32	6.57	5.97
1993	6.22	5.22	6.88	8.52	8.97	28.81	28.66	20.85	17.82	34.96	37.89	18.26	19.73	25.56	25.50	27.75	18.01	10.53	17.80	11.91	11.55	13.57	16.69
1994	5.12	10.00	19.07	13.60	22.52	28.94	27.40	25.27	22.71	18.55	15.16	17.87	14.35	11.58	10.81	8.99	7.55	6.73	4.63	3.79	4.39	3.58	2.95
1995	6.81	6.51	5.77	6.45	41.52	41.74	33.81	65.79	158.57	76.16	231.18	141.23	50.84	35.31	28.95	28.54	19.02	16.59	12.99	10.06	8.21	6.81	4.49

Appendix 1. Naturalized weekly flows (cms) during the cottonwood growing season
(weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 3 of 6)

UWAT = Waterton River at Waterton Park (Station 05AD003)

Year \ Week	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	7.76	12.80	15.03	15.56	23.36	54.16	60.54	53.97	46.13	59.34	49.47	42.91	36.24	37.81	33.73	32.23	23.41	16.93	11.84	9.25	7.56	7.34	7.93
1913	4.35	15.32	23.47	18.07	17.57	27.47	56.21	142.90	120.90	100.40	65.81	71.69	50.13	33.36	21.14	21.74	19.51	20.99	20.50	16.46	11.90	10.04	8.00
1914	10.23	21.81	31.27	40.14	45.63	63.91	64.97	56.64	66.56	54.16	60.36	39.04	36.93	29.94	22.64	15.06	12.16	10.00	10.78	15.26	13.01	9.47	7.85
1915	9.99	22.24	24.09	34.81	46.33	41.51	32.44	36.51	57.11	48.71	46.50	45.59	37.73	25.84	23.93	22.30	21.34	15.69	12.63	12.00	9.86	13.70	13.17
1916	9.93	15.11	15.06	31.71	49.60	29.07	31.39	34.79	59.67	92.17	168.70	113.90	108.00	90.90	59.34	37.09	25.20	21.67	19.14	17.17	16.01	20.04	19.16
1917	2.98	3.22	4.40	5.03	20.44	70.86	83.54	63.11	84.59	92.07	106.30	76.09	72.57	62.34	43.86	25.89	14.71	11.15	8.67	7.61	7.07	5.74	5.09
1918	10.71	18.47	21.36	23.86	34.90	46.31	30.17	28.43	58.47	113.70	73.84	44.24	24.46	18.41	15.51	13.81	10.81	11.02	9.76	8.67	7.56	7.72	8.82
1919	6.82	8.25	18.23	38.11	24.37	25.87	89.59	83.94	54.74	43.37	50.20	40.00	24.43	16.07	11.63	8.71	7.40	7.17	5.82	4.79	4.60	4.30	3.79
1920	3.24	4.39	6.32	10.27	21.53	42.36	56.69	37.30	48.90	91.76	112.60	75.60	87.40	58.94	40.17	26.66	17.16	12.77	12.06	8.48	7.26	6.00	5.99
1921	12.14	20.59	19.49	16.03	41.31	52.01	112.40	101.10	115.90	108.60	77.09	73.50	54.57	39.16	26.13	19.60	14.81	11.33	9.94	9.00	7.22	6.11	6.15
1922	2.98	3.08	8.00	25.97	23.79	59.01	86.61	86.50	119.80	95.73	80.40	49.64	35.39	33.67	20.47	14.64	11.37	9.89	7.46	5.86	5.51	5.43	4.84
1923	4.42	11.75	15.67	18.60	35.99	50.19	73.06	112.10	114.10	97.81	65.30	56.91	37.77	28.93	20.61	15.61	12.26	9.93	7.91	12.47	10.88	8.22	7.04
1924	4.81	5.54	6.82	14.58	38.91	89.93	74.50	54.86	73.51	111.40	84.10	51.83	46.29	27.33	17.73	14.71	11.00	13.37	12.29	11.60	9.12	7.55	5.91
1925	20.46	30.26	21.86	24.03	39.80	69.90	100.60	78.24	55.13	70.49	82.57	71.80	41.04	25.13	18.26	13.83	11.99	9.84	9.74	10.39	9.76	8.56	8.66
1926	10.34	33.44	32.33	42.86	31.79	26.13	25.11	20.09	18.47	17.90	20.07	20.09	17.31	12.96	10.90	9.42	7.76	7.03	5.35	4.75	6.57	16.13	18.73
1927	3.44	5.91	20.27	39.47	24.77	60.37	67.79	78.23	116.90	140.70	124.70	111.50	75.29	66.29	61.84	35.26	22.19	18.26	19.30	18.87	14.83	15.11	25.91
1928	6.89	5.63	9.09	25.91	56.63	91.87	119.70	92.80	43.44	60.40	85.71	89.44	91.69	74.70	42.86	21.67	19.17	13.00	9.65	8.76	10.30	9.99	8.55
1929	4.18	4.34	7.31	19.91	23.40	48.06	93.90	73.70	86.69	80.50	44.37	34.70	29.47	28.30	19.57	14.23	9.26	9.00	8.15	5.72	4.69	4.31	4.12
1930	21.24	31.80	45.56	60.69	49.93	42.23	66.24	60.39	68.39	61.19	47.17	36.93	31.51	26.29	21.69	15.69	11.24	8.59	7.28	5.62	4.52	4.45	5.04
1931	4.03	4.98	8.12	29.57	42.29	61.59	46.53	56.10	43.75	34.00	30.36	22.32	12.83	11.99	10.95	9.20	14.32	9.27	6.22	5.54	4.11	5.08	5.09
1932	7.61	11.18	13.12	14.99	50.10	75.75	82.33	47.55	60.36	68.22	70.35	61.87	36.59	23.48	18.30	14.91	12.29	9.56	8.43	9.12	8.27	6.77	5.36
1933	3.96	4.45	14.46	25.51	29.32	40.51	47.13	99.10	99.10	117.20	108.70	80.59	65.13	50.80	35.00	21.87	15.27	12.50	10.99	10.39	9.91	6.49	5.61
1934	18.81	43.13	80.70	64.33	87.41	79.53	60.46	72.69	105.30	84.62	46.53	39.30	27.33	20.93	17.51	13.89	12.53	9.31	7.61	6.48	5.84	5.42	4.55
1935	4.45	10.01	11.11	14.69	19.49	30.83	80.41	68.06	61.12	62.47	51.54	42.98	27.94	25.12	26.07	20.73	14.82	10.41	9.50	6.60	6.11	6.14	5.03
1936	7.41	17.20	23.77	25.68	51.73	76.41	44.43	67.32	54.24	42.57	34.34	31.05	17.05	13.56	11.16	9.81	7.86	6.45	6.09	5.86	4.15	4.54	3.92
1937	3.75	6.23	8.12	21.47	30.36	41.97	49.72	56.62	55.02	157.10	95.24	60.66	37.65	23.01	18.07	13.26	11.02	9.25	7.00	5.81	4.22	4.84	4.62
1938	5.91	23.27	21.84	34.77	29.48	56.54	87.26	111.00	84.59	63.16	75.61	64.03	43.48	30.56	22.59	17.08	11.48	8.00	6.86	6.53	5.90	5.26	5.41
1939	6.01	12.61	31.96	52.77	39.74	51.62	37.75	52.25	33.29	33.18	33.41	30.30	23.76	19.62	14.15	10.52	10.07	7.16	5.98	4.98	4.39	4.48	4.19
1940	3.92	9.52	13.87	20.27	34.51	49.47	50.36	50.09	41.73	43.18	36.28	25.93	15.32	12.24	10.29	11.31	10.32	6.69	5.25	4.42	4.03	4.39	4.42
1941	6.76	8.94	13.15	26.92	21.60	30.23	27.63	35.58	33.24	28.01	21.22	29.45	22.69	13.68	11.00	8.47	6.71	5.72	5.32	4.63	4.51	5.58	6.73
1942	8.94	17.69	28.73	17.72	39.60	38.57	62.48	56.10	104.30	59.64	38.66	65.99	45.47	31.46	22.78	18.80	15.95	13.91	10.87	9.12	7.35	6.40	6.70
1943	14.24	43.35	32.60	28.42	24.97	24.26	65.74	81.26	55.58	75.12	109.40	79.78	67.55	54.35	35.35	32.11	21.59	15.64	11.01	8.55	7.02	6.33	4.83
1944	4.18	3.78	3.81	11.87	17.12	34.51	40.33	36.84	36.79	34.88	33.47	35.03	22.09	13.12	9.44	8.56	7.38	6.02	9.32	8.58	6.75	6.15	5.30
1945	2.81	3.51	3.53	16.30	49.74	48.57	47.07	83.58	91.91	57.52	77.35	66.62	35.71	28.79	20.01	15.15	10.92	7.99	6.35	4.85	3.80	8.78	8.51
1946	8.21	17.72	36.08	38.29	43.89	61.50	59.01	80.41	75.72	62.37	60.05	42.61	34.02	31.24	21.88	15.50	11.99	8.55	6.61	6.20	6.86	6.60	6.95
1947	7.45	18.94	34.41	68.34	80.89	58.31	47.16	53.88	61.49	61.72	55.78	55.55	37.99	33.85	24.93	18.36	12.84	10.26	7.53	10.51	9.02	6.53	5.42
1948	2.89	8.61	19.51	21.24	25.43	31.89	132.20	140.10	134.10	113.80	123.70	66.14	38.06	21.63	16.40	15.74	23.26	16.67	12.16	9.29	6.89	5.58	4.59
1949	4.77	11.19	19.80	25.54	39.33	82.39	66.44	80.30	71.99	54.67	32.31	30.57	21.66	19.77	17.31	14.14	13.57	9.94	6.53	5.60	4.93	4.97	5.09
1950	4.21	8.65	11.59	9.97	14.42	54.93	53.36	67.56	85.51	101.90	128.40	97.91	98.94	65.79	41.54	31.81	23.37	16.66	12.63	10.22	8.27	6.95	5.83
1951	12.53	16.80	18.54	40.17	74.29	84.54	95.09	54.33	39.09	87.13	84.70	92.47	89.16	73.39	62.41	39.00	27.27	18.60	13.50	10.87	22.66	31.04	21.07
1952	6.76	19.33	37.10	54.34	35.80	55.90	67.24	56.17	55.14	50.83	37.59	34.30	34.19	26.43	21.63	17.87	13.53	15.57	15.81	10.40	7.44	6.30	5.65
1953	5.28	5.96	20.44	27.94	46.97	41.2[illegible]	62.79	99.06	160.10	136.90	82.54	57.44	65.89	67.74	47.94	27.27	18.46	15.23	11.73	9.07	7.44	7.24	6.21
1954	5.20	9.04	9.96	8.48	24.34	79.87	120.20	75.89	69.87	77.14	69.57	91.70	94.60	84.01	62.14	35.44	23.49	17.91	14.09	13.59	22.30	17.50	11.91
1955	3.57	4.91	5.15	6.17	11.69	26.94	47.63	44.71	76.16	111.40	94.90	92.94	48.73	59.23	51.36	31.37	19.63	14.03	9.84	7.57	6.18	5.06	4.89
1956	4.57	14.76	24.09	16.20	16.80	38.01	123.60	115.10	99.59	73.03	70.66	52.39	49.24	45.69	36.26	26.04	18.19	12.94	10.81	8.96	7.93	6.59	5.69
1957	2.66	2.74	7.66	51.31	89.01	98.20	90.93	82.73	93.63	67.30	44.09	33.86	25.19	19.03	14.97	11.02	8.61	6.92	5.63	4.64	4.09	3.29	2.92
1958	6.00	11.50	12.13	17.26	66.06	80.36	100.30	84.54	72.90	69.61	49.26	35.91	24.56	21.56	17.16	15.27	12.10	8.42	6.91	5.86	5.27	4.05	3.78
1959	11.74	15.67	17.84	32.16	29.80	45.26	54.44	54.81	116.00	90.30	100.60	75.59	54.56	42.67	38.80	28.61	17.69	11.66	8.67	8.31	8.98	12.06	21.29
1960	20.80	17.70	13.17	12.09	24.67	61.16	30.51	42.31	92.84	75.90	63.50	51.06	48.26	35.80	26.89	18.86	14.47	13.90	9.75	6.74	5.43	5.27	5.41
1961	8.12	7.90	6.98	11.70	19.29	32.00	95.93	123.90	122.60	84.83	79.63	46.64	27.21	21.67	17.37	14.17	10.73	8.44	6.85	5.84	5.12	5.18	5.25
1962	8.37	20.67	38.16	25.60	20.81	36.84	60.89	65.00	49.54	68.51	68.77	49.56	30.51	22.27	17.17	14.04	12.79	10.23	8.01	6.47	5.81	5.60	6.25
1963	5.98	9.12	10.04	19.76	28.63	32.87	56.16	75.34	87.56	105.20	71.33	57.10	64.20	40.24	23.31	15.79	11.30	9.05	8.44	6.84	5.39	4.40	4.28
1964	3.93	4.76	6.53	18.53	31.03	44.87	72.61	57.20	220.10	191.30	88.09	84.39	62.80	51.23	34.84	21.71	15.79	11.41	9.18	7.27	6.29	7.19	8.07
1965	4.84	8.63	18.54	34.86	28.87	55.87	43.34	73.24	86.29	103.70	124.10	76.59	59.47	54.53	35.97	23.79	16.99	15.87	12.41	10.15	8.52	7.87	9.00
1966	17.46	16.79	12.79	16.56	61.53	42.30	44.21	103.90	92.01	77.19	63.03	48.01	45.34	35.57	25.23	17.51	12.64	10.30	8.30	11.37	11.09	8.92	7.42
1967	4.29	5.53	6.33	7.64	14.28	32.39	107.00	95.76	95.50	96.06	112.90	95.17	79.96	52.50	35.44	23.24	17.37	13.20	10.32	8.60	6.66	5.32	4.79
1968	6.32	6.28	6.23	12.11	22.76	29.94	66.09	73.01	89.20	81.44	63.53	54.21	41.14	39.07	25.10	18.77	14.90	11.83	11.14	12.49	11.21	10.35	9.22
1969	13.89	20.53	31.69	27.10	40.07	68.33	57.73	75.61	96.76	60.36	44.01	83.66	53.66	32.27	21.41	15.91	11.93	8.35	6.39	5.20	4.57	3.98	3.58
1970	3.09	3.75	4.28	7.38	37.50	53.40	90.39	81.91	117.60	131.20	108.70	65.57	36.07	26.74	19.17	14.00	11.04	8.99	6.66	5.26	4.54	4.33	4.59
1971	4.09	6.91	24.33	38.57	75.76	71.14	54.69	105.90	93.34	78.69	64.49	73.26	54.37	46.04	45.96	37.31	25.46	20.69	13.91	8.79	7.26	6.73	5.46
1972	14.21	11.74	9.99	17.29	21.99	67.01	92.63	107.40	137.60	112.70	74.37	58.73	55.61	52.31	49.71	46.44	35.76	25.63	19.20	16.56	14.64	11.14	11.37
1973	4.46	6.55	8.38	10.92	19.07	60.51	71.74	47.86	65.69	64.74	40.70	44.47	27.21	19.00	14.20	10.95	8.73	7.95	6.64	5.38	4.68	4.85	4.31
1974	5.96	8.82	23.04	36.63	54.89	32.09	30.33	66.20	79.50	119.00	158.00	115.60	73.07	55.03	50.10	36.67	25.27	19.07	15.66	11.43	9.67	7.98	7.56
1975	2.15	2.37	3.82	6.01	26.91	66.44	46.46	56.16	112.70	98.63	250.30	100.30	100.00	94.87	45.66	26.43	24.06	16.00	11.46	11.53	15.21	13.57	9.99
1976	11.04	19.99	14.40	18.27	67.49	80.01	62.13	60.67	38.63	51.81	58.73	50.80	55.06	53.69	39.24	27.63	20.36	22.13	24.07	19.24	14.93	10.64	8.33
1977	6.32	7.88	14.63	34.79	33.97	34.47	26.01	25.93	41.01	33.60	24.21	17.30	11.43	8.62	7.76	7.97	6.14	7.51	9.94	10.43	10.68	13.36	12.30
1978	9.43	9.15	10.25	31.61	36.57	55.06	65.89	45.64	95.14	74.47	56.91	62.34	55.96	37.34	34.70	25.29	17.01	11.31	9.39	12.09	12.66	10.59	14.70
1979	4.85	5.53	7.05	19.64	26.06	41.24	77.87	74.34	75.97	61.99	47.89	38.44	29.86	22.00	15.09	11.76	8.38	6.56	5.53	6.24	6.04	5.07	4.49
1980	3.01	8.33	39.96	71.03	59.36	42.81	80.07	102.40	54.46	70.97	62.31	30.29	19.41	15.00	12.70	10.66	8.38	7.13	7.17	6.66	7.74	7.30	7.35
1981	5.59	6.82	25.96	53.60	37.09	49.86	129.90	95.94	68.91	52.47	52.64	52.61	51.23	33.63	26.39	24.50	17.40	11.99	9.64	7.45	6.05	5.24	4.21
1982	3.44	4.21	6.72	12.56	15.11	32.06	64.79	54.67	65.33	94.83	105.30	91.37	65.40	40.06	31.13	22.84	17.99	13.67	10.84	8.70	7.17	5.88	5.13
1983	3.87	4.80	16.36	16.63	19.86	20.21	51.96	66.99	62.64	57.46	39.40	34.70	30.09	29.23	32.90	21.74	15.04	12.23	9.72	7.22	5.90	5.10	4.25
1984	3.44	9.74	20.50	14.80	12.54	26.63	44.31	52.63	50.90	46.71	63.79	61.37	40.96	26.77	19.74	14.46	12.84	10.21	7.84	6.18	4.40	3.83	4.80
1985	8.21	21.96	18.39	40.89	38.46	37.41	84.94	68.11	64.63	56.47	43.23	26.83	22.49	17.90	12.46	9.04	7.07	6.43	11.55	12.34	9.02	8.04	16.78
1986	14.77	14.46	28.34	23.83	27.71	25.81	57.99	123.30	84.69	53.84	35.69	25.49	20.39	15.21	11.84	10.02	7.72	6.69	5.59	4.42	4.13	4.39	5.66
1987	11.70	19.53	27.41	68.64	72.11	63.07	36.23	56.69	40.26	36.23	27.74	18.36	14.83	12.23	20.84	39.74	20.11	12.46	12.56	12.50	12.59	9.66	7.53
1988	9.46	20.29	23.96	20.67	27.04	56.74	48.43	51.89	52.86	43.00	33.31	25.50	18.37	13.26	9.68	7.36	6.36	5.56	4.78	3.99	3.50	2.95	2.59
1989	5.99	15.03	29.84	28.44	70.31	48.73	33.07	33.17	80.63	95.61	53.00	40.39	31.40	25.24	23.83	17.36	12.49	9.16	7.94	9.24	20.27	20.17	18.27
1990	12.63	17.20	35.16	28.10	42.29	31.07	42.86	74.50	52.33	58.61	69.73	64.53	58.54	40.44	30.67	28.51	23.89	15.09	10.94	9.75	7.27	5.81	4.82
1991	14.17	12.31	22.61	21.11	24.94	85.21	111.64	74.63	88.93	83.04	101.81	94.60	83.86	54.33	40.44	28.53	22.46	17.41	13.79	10.45	7.94	6.45	5.71
1992	7.70	9.43	13.33	31.59	44.16	28.27	29.76	34.84	32.56	31.33	32.80	24.40	26.39	21.81	17.06	13.23	10.34	8.24	6.63	6.14	7.15	6.66	5.79
1993	6.78	7.65	9.25	11.38	23.23	79.90	69.14	54.00	40.91	36.17	47.24	30.07	28.33	38.46	36.41	30.24	25.26	15.90	12.64	12.53	11.81	12.17	11.34
1994	6.58	13.26	29.64	20.59	46.96	60.00	52.77	55.97	44.90	37.41	29.59	30.26	23.09	15.96	12.10	9.79	7.88	6.52	5.36	4.44	3.68	3.19	2.66
1995	6.78	6.91	8.32	10.96	33.77	58.10	57.27	89.83	217.57	98.90	87.79	76.46	61.60	50.31	34.74	29.57	20.77	15.99	13.13	10.67	8.59	7.16	6.14

Appendix 1. Naturalized weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 4 of 6)

LWAT = Waterton River at Standoff & Glenwood (Stations 05AD008 & 05AD028)

Year \ Week	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	19.60	21.35	22.68	26.77	41.02	70.04	70.57	64.15	55.17	73.15	58.71	67.44	42.42	40.84	30.17	42.18	33.11	21.97	17.33	14.81	13.20	12.47	12.40
1913	21.94	29.74	33.27	27.93	31.00	42.92	73.41	180.80	150.70	125.90	93.65	100.20	84.90	48.09	28.75	31.78	29.72	33.24	27.58	19.26	17.90	14.70	11.50
1914	11.69	24.99	33.15	47.96	51.65	66.14	73.82	67.96	67.06	72.06	68.32	53.29	42.28	41.94	30.01	21.30	20.15	15.83	15.18	18.59	13.85	10.72	9.89
1915	13.07	24.05	26.24	42.08	56.10	64.72	45.16	51.66	97.25	74.28	72.78	84.41	53.47	38.13	32.73	39.14	35.99	25.21	21.70	21.00	17.83	23.64	20.05
1916	20.60	22.16	21.76	35.13	58.34	36.04	46.03	66.00	88.21	112.90	216.30	148.70	128.40	109.40	75.89	42.81	26.19	23.80	21.67	21.90	18.70	24.83	23.00
1917	16.51	10.48	11.82	16.91	38.43	88.34	94.99	112.00	95.64	118.60	130.10	96.04	86.44	55.96	44.39	28.91	18.91	15.03	11.64	10.17	9.00	7.69	6.56
1918	18.11	23.83	27.59	46.75	75.49	56.27	35.69	33.99	58.39	113.50	76.76	48.99	26.91	21.24	17.81	16.67	13.39	12.29	12.96	11.03	9.43	13.80	16.91
1919	6.98	7.71	13.81	30.23	27.29	30.73	94.53	96.23	54.96	41.44	48.50	43.47	44.34	23.37	9.47	8.87	10.67	10.23	9.66	6.99	5.59	5.52	5.38
1920	10.34	15.09	19.54	22.81	51.14	66.19	66.89	48.66	60.63	100.70	118.00	81.71	85.54	64.80	47.56	30.93	19.24	13.80	14.19	12.29	9.17	7.16	6.90
1921	17.21	29.34	26.07	23.30	58.33	61.20	115.10	110.30	123.90	110.60	88.90	79.67	65.77	47.00	30.33	23.30	19.67	14.71	12.17	9.42	7.72	6.86	7.64
1922	6.52	19.37	16.67	43.54	36.71	73.64	107.90	110.70	148.70	103.90	88.09	60.07	41.30	45.63	27.73	17.27	13.91	11.30	10.66	9.32	7.70	6.99	6.57
1923	8.40	15.50	19.29	25.86	46.26	63.17	90.26	203.60	192.90	135.90	113.70	93.24	54.26	37.50	30.31	22.76	17.09	13.94	11.59	28.26	18.70	12.59	10.81
1924	13.00	9.58	11.09	21.71	46.33	87.83	77.71	60.30	103.80	140.90	113.10	63.43	54.01	38.80	28.89	21.23	17.47	26.76	23.09	18.89	13.04	9.55	7.79
1925	36.79	51.10	44.87	38.73	50.13	102.60	143.00	104.70	73.77	93.76	104.00	78.09	55.24	34.53	24.99	19.93	15.03	12.07	12.09	13.44	11.23	10.58	10.17
1926	11.98	39.39	42.34	49.83	40.30	32.63	29.39	22.04	18.86	19.91	39.09	39.43	26.11	15.26	12.07	9.82	7.29	6.90	6.97	5.70	6.36	22.01	36.10
1927	12.24	23.20	44.06	59.20	43.64	79.69	141.30	193.10	191.40	198.90	148.60	133.70	103.90	90.83	88.43	53.57	35.24	23.54	27.24	32.50	19.66	18.47	83.10
1928	15.71	15.21	21.87	33.49	62.30	109.80	156.70	107.70	56.63	69.56	150.70	152.60	171.30	70.40	50.90	35.70	28.56	20.00	14.46	12.10	27.04	18.59	13.21
1929	8.95	11.56	21.96	31.84	46.77	66.73	115.20	98.31	121.60	100.50	60.11	42.06	41.63	37.34	25.13	17.40	12.93	10.86	8.67	6.03	5.29	6.15	6.09
1930	27.57	38.11	52.19	70.56	65.37	57.61	79.14	79.14	80.64	72.93	60.30	48.89	34.10	27.06	24.61	20.10	14.61	10.63	9.64	8.36	6.58	5.78	8.30
1931	5.51	6.32	7.87	29.00	42.47	76.49	52.02	62.07	59.54	47.08	40.09	31.41	17.07	15.77	14.30	11.92	17.80	12.37	8.68	7.67	5.86	6.30	7.12
1932	12.99	17.50	25.30	23.02	58.83	95.12	110.90	66.76	75.61	80.93	92.66	79.44	48.02	31.43	23.85	19.75	16.49	12.84	11.43	12.02	9.81	6.67	6.45
1933	5.99	8.07	20.65	36.04	46.34	55.66	60.62	110.00	137.30	135.50	125.70	92.13	66.42	53.25	38.42	27.93	20.74	17.74	15.05	13.64	10.95	8.72	7.30
1934	35.37	53.65	99.90	85.28	113.50	102.20	81.72	92.20	125.70	117.90	56.01	53.79	37.59	28.36	21.78	18.61	16.61	12.48	10.27	8.82	7.65	7.41	6.47
1935	9.05	15.44	13.97	21.14	27.36	32.89	81.23	77.80	74.10	73.07	64.07	51.80	39.41	33.51	30.87	24.44	17.91	12.26	9.11	7.40	6.62	6.91	6.49
1936	20.31	13.21	31.36	32.16	60.33	107.80	65.79	84.39	88.06	53.74	35.77	26.67	22.96	17.47	14.42	12.57	8.06	5.56	5.26	6.32	5.10	5.53	5.37
1937	6.75	7.96	9.56	21.27	37.84	53.03	63.94	94.31	88.66	230.30	120.60	58.47	39.34	25.83	20.13	14.67	13.10	10.26	8.66	8.36	6.04	6.55	5.22
1938	12.01	23.00	31.91	48.63	44.36	58.06	119.20	135.30	112.50	90.26	94.77	83.86	57.31	35.71	23.81	18.37	14.19	11.59	10.16	8.58	7.55	7.02	7.00
1939	8.28	8.57	32.09	55.63	53.91	59.81	53.59	52.07	39.93	45.79	50.96	40.37	30.86	21.50	15.46	10.04	7.94	7.47	5.78	4.47	3.91	4.07	4.32
1940	6.70	10.30	23.74	28.59	37.91	80.66	58.39	62.60	52.14	47.73	40.97	30.81	22.83	16.30	12.31	12.67	19.06	10.47	6.90	6.00	5.01	5.63	5.44
1941	7.59	11.89	17.87	38.74	34.59	42.29	47.66	51.67	47.63	37.19	32.19	34.00	32.31	25.01	18.29	14.10	10.40	7.77	6.95	6.37	7.86	7.39	10.40
1942	13.74	23.79	42.27	31.53	54.40	76.66	100.20	88.50	215.80	89.40	63.27	120.10	91.41	55.50	37.54	31.79	36.30	27.59	20.43	14.99	14.39	15.01	12.71
1943	31.81	58.30	55.13	47.94	43.91	46.99	79.60	123.70	79.91	94.40	119.20	91.44	92.34	74.91	50.46	41.44	31.21	20.41	13.60	9.69	8.81	8.65	7.82
1944	5.79	5.33	5.25	9.40	17.17	43.83	55.71	46.77	48.89	45.57	55.83	47.23	35.53	22.29	13.61	9.46	7.63	6.23	9.89	9.94	8.34	7.39	5.81
1945	4.44	5.89	7.14	19.24	61.39	67.61	65.89	126.10	156.10	95.63	103.50	96.06	52.11	36.11	24.39	15.93	11.67	9.74	8.11	6.32	5.48	4.77	7.48
1946	8.36	16.60	31.67	44.43	55.69	68.37	90.36	107.60	102.90	85.34	74.04	56.74	41.53	38.07	26.43	17.56	12.97	9.72	7.68	6.32	7.68	11.31	13.21
1947	17.11	23.66	39.80	77.17	106.30	80.61	60.61	75.33	83.87	94.40	69.33	62.11	52.09	41.49	28.74	20.37	13.84	10.19	9.21	11.88	14.37	10.14	7.88
1948	4.95	47.77	35.47	35.66	48.17	84.74	183.90	189.10	173.30	246.90	238.00	114.10	83.85	36.51	30.37	26.07	44.66	30.40	20.29	14.16	11.70	9.66	7.74
1949	10.59	12.66	17.91	23.41	29.79	99.66	104.00	110.00	87.56	70.73	45.57	35.23	26.14	31.11	34.19	25.77	21.93	18.87	15.00	12.36	10.86	9.91	9.98
1950	21.87	29.29	28.01	24.59	34.40	80.81	71.60	83.34	98.90	129.10	163.80	115.90	114.00	79.80	50.80	39.93	31.39	24.04	19.70	15.50	11.49	9.53	8.33
1951	29.60	33.04	38.90	91.71	109.60	140.40	130.90	86.36	94.04	131.30	126.50	182.10	150.40	138.00	107.60	75.20	58.20	50.39	43.83	38.90	66.41	87.13	62.26
1952	27.44	42.94	51.17	68.63	50.27	77.21	94.33	71.73	88.79	71.74	48.43	46.24	42.61	37.46	40.13	32.13	19.80	28.83	32.91	17.17	13.49	11.24	9.57
1953	7.70	12.37	50.34	60.86	76.53	62.61	87.26	156.30	273.60	157.90	100.30	73.53	72.04	76.61	61.23	41.74	29.59	23.40	17.63	12.66	10.06	9.67	8.13
1954	14.58	21.14	16.03	16.90	50.29	111.20	160.40	105.50	98.10	90.93	105.30	109.90	127.90	106.90	80.39	43.30	29.24	21.54	16.34	16.31	28.11	22.27	14.83
1955	20.92	10.90	12.14	12.36	21.39	82.19	97.03	64.03	96.71	138.70	121.60	114.20	63.47	74.63	64.56	41.10	26.36	18.40	13.06	8.12	8.09	6.72	4.83
1956	16.73	20.04	35.87	24.99	35.33	66.47	165.40	147.00	127.30	94.63	92.13	65.99	82.09	54.06	48.53	30.17	24.73	17.54	12.71	11.17	10.26	6.91	6.90
1957	5.96	7.60	13.39	52.87	99.04	130.70	132.10	98.99	114.70	92.17	60.21	36.69	26.29	20.97	17.24	12.84	10.84	9.72	7.65	6.39	6.14	6.03	6.16
1958	25.47	21.16	17.61	24.91	87.06	128.70	127.40	110.60	106.30	104.90	75.37	54.40	37.83	34.69	24.11	21.21	15.90	10.89	9.40	8.57	7.50	7.03	6.96
1959	17.67	28.03	29.01	52.29	46.94	74.81	96.50	76.00	145.40	109.70	117.90	105.70	73.01	50.66	48.66	36.67	22.56	13.96	11.74	11.01	10.67	10.62	21.46
1960	27.50	24.13	18.83	24.21	47.84	82.91	46.24	55.61	103.10	83.70	67.54	51.56	55.74	42.54	30.31	22.74	18.89	21.66	12.41	8.29	6.71	5.92	5.46
1961	9.36	10.06	12.20	16.96	31.17	62.70	147.40	173.00	165.30	125.90	101.90	60.03	36.63	27.44	20.36	16.93	13.39	9.22	7.69	6.23	5.55	5.74	5.89
1962	15.80	27.04	52.09	31.54	25.80	45.17	73.71	76.24	55.91	94.16	75.97	58.21	38.29	27.83	22.37	16.43	15.36	12.47	9.84	8.44	6.54	7.78	7.64
1963	5.39	11.92	9.41	21.33	35.00	40.63	64.39	83.47	94.69	128.10	90.23	82.14	88.33	47.97	28.30	18.19	12.97	10.74	9.33	7.28	7.79	5.45	5.35
1964	7.08	6.80	7.05	58.52	59.74	62.31	100.20	79.80	204.90	317.30	127.00	110.10	87.11	77.37	45.90	24.97	16.34	11.66	9.17	7.21	7.31	6.76	9.96
1965	15.50	16.84	17.56	18.80	11.02	6.67	24.93	55.57	102.20	123.10	176.10	145.20	80.20	75.39	52.40	40.19	25.09	23.64	15.84	12.90	10.70	10.38	11.29
1966	22.24	21.37	18.41	22.67	81.46	54.81	55.21	128.70	151.10	109.40	81.99	69.21	65.24	54.36	41.00	28.39	18.36	15.11	9.45	18.19	17.01	12.83	10.19
1967	9.48	9.52	11.56	15.51	62.91	94.56	158.60	137.90	158.30	155.60	153.60	125.10	102.30	84.84	41.87	26.53	18.01	12.86	12.30	10.68	8.46	6.37	5.88
1968	8.92	8.93	9.81	14.14	30.97	37.29	86.41	93.16	121.60	109.10	80.24	68.2[illegible]	55.33	50.37	28.81	22.39	17.31	13.53	14.97	17.74	14.37	14.50	13.47
1969	27.83	29.23	40.74	59.51	70.64	123.40	93.07	101.40	137.20	82.86	51.76	181.80	74.61	38.64	26.21	20.27	14.89	11.29	8.84	6.08	5.33	5.96	4.20
1970	8.51	6.58	6.90	17.38	53.80	71.21	114.50	103.10	136.90	182.90	140.90	78.54	35.49	28.49	22.71	19.23	14.97	13.60	10.16	6.92	5.29	5.01	6.46
1971	8.13	11.59	29.61	44.49	99.70	89.51	73.74	139.00	115.90	95.06	67.40	86.06	58.69	51.96	48.56	42.10	31.00	24.29	16.80	12.67	9.35	8.34	5.84
1972	22.11	18.39	19.27	29.24	35.57	92.26	126.60	137.90	177.10	146.70	85.61	65.19	59.44	57.97	80.30	62.41	46.17	37.73	25.17	21.06	18.01	14.93	14.23
1973	8.29	8.48	15.43	17.46	25.41	69.50	80.93	55.77	72.33	71.90	44.81	48.21	30.60	21.53	16.36	12.63	10.52	9.35	7.55	6.08	5.74	5.91	4.76
1974	9.81	13.10	33.73	57.30	67.07	46.63	48.00	82.73	98.81	134.70	173.90	118.50	79.31	61.77	53.43	38.99	29.20	19.81	24.89	13.79	10.43	8.28	8.10
1975	2.58	10.04	35.76	25.01	80.80	111.40	80.07	89.39	150.10	119.90	379.10	126.70	119.50	115.40	64.11	42.59	29.67	15.69	15.06	16.46	20.50	18.73	13.91
1976	17.96	32.27	24.04	30.99	89.64	100.80	72.20	71.19	43.77	63.74	71.14	59.37	62.10	63.94	47.64	34.56	24.17	40.37	33.74	23.14	18.03	12.16	11.24
1977	5.94	7.95	15.08	35.69	34.74	41.70	30.79	29.77	40.80	41.49	28.77	20.57	15.66	10.90	8.80	8.41	9.23	10.38	13.74	14.93	14.63	17.57	17.69
1978	12.31	12.66	12.38	42.64	48.59	68.34	80.63	55.69	113.20	86.29	62.43	67.90	55.79	45.74	48.60	34.86	21.20	16.17	10.23	13.76	19.10	12.93	17.34
1979	15.73	15.56	18.04	35.06	45.56	58.93	95.37	89.87	86.76	67.67	57.53	42.21	38.16	27.69	19.30	16.03	10.94	8.33	6.91	9.57	10.10	7.46	6.00
1980	4.58	11.03	45.90	88.14	73.09	46.81	108.60	138.50	80.31	91.13	76.94	38.71	23.13	19.17	17.76	13.41	10.69	9.81	10.78	12.79	12.14	11.34	10.07
1981	10.10	10.04	29.16	62.90	50.89	97.99	204.70	113.70	77.96	86.33	65.84	62.40	58.21	41.06	34.94	37.97	25.83	17.47	14.09	11.31	9.10	9.25	6.28
1982	9.23	7.55	9.41	18.70	20.87	33.53	75.47	73.44	78.53	99.80	120.70	97.89	71.86	46.99	37.53	26.56	20.11	17.00	11.91	9.71	8.53	6.15	5.73
1983	6.18	6.16	16.61	23.29	24.27	28.36	67.01	103.20	69.71	86.93	49.60	41.44	38.24	32.84	40.57	28.69	20.04	14.89	13.40	10.25	7.56	5.83	5.08
1984	4.26	7.90	24.76	21.27	17.26	30.57	52.67	55.33	63.37	55.07	75.33	74.89	50.27	35.54	25.73	20.30	17.56	15.24	10.53	8.79	6.47	5.52	5.99
1985	8.37	23.24	21.31	40.74	51.49	40.37	97.30	83.11	74.23	66.00	54.54	37.06	28.69	23.76	17.44	13.59	8.35	6.83	15.20	20.17	14.81	10.84	27.80
1986	19.04	17.99	39.10	29.64	40.46	37.37	69.29	149.70	101.10	62.03	46.66	31.84	25.93	18.31	14.40	11.69	9.04	8.59	6.84	5.66	5.52	6.00	8.82
1987	17.19	27.94	34.73	81.54	81.87	80.14	44.33	74.10	48.41	45.67	36.23	26.24	20.33	17.98	36.71	76.94	31.26	19.64	25.44	20.49	24.51	18.74	14.49
1988	10.57	19.01	28.16	24.47	31.34	64.44	57.43	61.46	57.70	54.77	39.09	28.57	21.76	16.39	11.84	8.04	7.10	6.74	5.56	4.99	4.66	4.16	3.85
1989	9.98	17.19	36.83	37.76	82.24	61.10	40.97	45.57	91.51	122.96	65.33	50.36	37.15	32.20	30.68	21.19	14.22	10.81	10.11	10.20	27.52	25.29	24.43
1990	17.91	24.91	46.48	46.19	59.09	41.35	58.82	112.96	69.66	71.21	77.40	96.48	68.85	45.82	34.91	36.47	29.73	17.65	13.96	13.82	9.17	7.83	5.80
1991	19.88	17.83	29.78	33.06	29.75	108.10	130.53	85.51	100.95	95.81	150.39	125.67	96.86	66.59	50.88	33.66	26.61	19.60	17.14	12.75	9.81	7.52	6.63
1992	10.93	9.41	13.97	30.96	46.64	30.35	31.72	36.96	34.92	41.06	44.44	30.16	49.26	36.60	25.08	21.36	15.75	11.60	8.62	8.09	14.31	11.34	8.72
1993	16.55	18.29	17.09	15.27	29.49	93.61	87.99	71.08	55.63	70.20	72.16	39.43	37.77	41.68	45.68	83.30	40.89	25.03	36.31	24.57	21.33	24.20	33.51
1994	16.54	21.74	45.99	33.67	59.61	81.59	81.26	70.36	56.07	48.09	36.74	35.96	27.27	18.05	16.36	12.89	10.17	10.37	7.90	6.21	6.46	5.00	3.98
1995	8.52	9.11	12.76	19.98	109.71	109.89	89.84	127.21	376.01	141.87	156.73	131.56	102.88	69.24	49.28	53.54	30.47	22.07	17.41	14.81	11.73	9.80	8.04

Appendix 1. Naturalized weekly flows (cms) during the cottonwood growing season
(weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 5 of 6)

USTM = St. Mary River at US / Canada Border (Station 05AE27)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	13.34	17.13	19.90	22.17	29.83	64.17	87.81	75.60	57.99	75.54	65.20	67.20	52.54	45.13	40.11	45.53	34.70	31.43	23.77	21.64	17.06	15.27	16.67
1913	13.76	32.27	31.34	27.91	28.29	39.87	68.86	144.00	144.40	136.70	109.80	107.20	83.51	63.00	40.37	41.13	37.34	41.30	35.80	25.54	23.53	20.76	16.30
1914	11.90	21.43	30.26	45.31	52.59	72.11	76.59	69.09	74.79	61.69	67.56	50.10	52.26	49.84	37.41	26.34	23.36	20.43	18.83	21.47	17.66	14.49	12.66
1915	10.34	21.36	25.69	43.44	53.81	53.60	38.40	46.80	70.89	62.16	63.51	70.56	63.13	47.01	43.86	38.77	36.96	29.50	26.77	24.67	20.03	32.99	21.97
1916	18.00	19.27	19.51	30.60	56.89	43.83	48.89	56.91	61.17	107.40	217.40	160.70	151.70	113.60	90.73	58.64	42.87	39.20	35.97	30.77	28.80	40.37	31.67
1917	17.14	11.61	13.71	14.67	33.77	85.49	86.71	102.10	103.90	131.60	130.60	105.00	89.01	81.37	63.24	45.19	29.61	22.54	20.19	19.37	16.99	13.63	14.49
1918	17.67	23.39	25.71	42.76	71.61	58.69	40.66	35.14	59.60	130.90	86.56	51.63	33.09	35.77	33.01	27.23	22.77	22.09	24.59	20.67	17.86	15.34	14.21
1919	7.04	6.45	14.43	40.14	32.12	29.64	78.81	113.40	66.01	49.73	56.68	49.26	34.91	27.67	22.63	18.67	18.20	15.85	13.26	12.29	10.94	12.34	9.56
1920	10.37	20.03	12.50	14.81	36.77	56.20	74.21	51.28	57.47	108.70	118.20	82.64	91.36	69.29	66.66	51.28	35.27	27.92	21.82	18.56	15.38	15.92	15.92
1921	15.48	23.85	22.57	22.99	52.13	66.39	127.80	111.60	120.90	120.00	87.61	90.13	70.68	54.20	44.03	37.07	30.22	23.71	21.60	17.70	14.75	13.60	11.55
1922	4.45	5.69	13.83	32.01	31.81	55.86	109.20	104.50	142.20	116.00	103.20	73.14	60.50	54.06	38.52	28.12	22.62	20.77	17.35	15.82	14.37	13.63	11.59
1923	8.86	13.53	17.77	29.20	51.69	68.49	85.57	101.60	106.50	109.10	83.40	72.70	66.51	47.49	45.49	37.64	27.91	18.34	17.13	27.90	22.38	18.46	14.91
1924	13.42	9.39	9.64	15.19	36.45	81.89	80.10	66.92	85.76	101.60	106.10	72.53	70.38	51.67	35.20	25.79	22.99	22.02	21.05	18.84	17.98	12.49	12.82
1925	32.83	48.20	45.38	45.34	56.93	100.50	162.00	123.10	84.87	88.75	111.20	107.90	79.07	58.07	45.54	32.99	29.53	23.50	21.65	22.59	17.03	17.12	12.91
1926	7.92	28.50	33.68	47.91	39.80	28.29	32.81	25.60	27.74	27.19	33.88	36.57	30.88	26.38	20.49	15.63	14.38	11.85	10.80	10.21	12.29	23.94	24.95
1927	4.84	17.31	36.66	46.92	36.85	73.71	107.30	128.50	137.80	188.00	157.80	146.20	105.60	86.83	70.69	57.04	46.01	34.72	34.76	38.53	28.72	36.76	55.11
1928	10.57	13.30	21.91	37.99	78.89	112.80	142.50	127.10	72.79	58.17	81.32	117.40	115.20	73.09	65.37	50.94	44.22	31.46	23.79	17.69	21.79	19.20	15.35
1929	7.91	8.38	12.71	20.26	29.60	52.12	95.01	74.62	88.85	88.84	55.72	44.65	46.24	41.31	33.95	25.42	19.95	16.74	13.80	10.32	10.02	10.17	7.74
1930	33.99	44.21	59.65	77.74	65.67	55.08	76.79	76.63	79.60	78.56	59.60	54.29	44.96	40.42	33.81	26.54	19.14	16.47	15.38	11.80	9.59	7.82	11.04
1931	5.67	6.39	7.38	25.76	42.72	86.11	55.93	67.58	64.36	52.20	45.20	34.40	26.42	23.41	21.16	17.97	28.20	20.25	13.35	11.86	9.70	12.89	12.19
1932	11.13	16.78	22.99	20.35	53.08	91.08	107.40	63.69	76.86	83.35	92.00	81.54	63.76	43.43	32.70	26.66	22.17	17.61	15.73	16.63	14.30	10.07	9.68
1933	8.06	10.05	17.51	35.17	39.58	49.76	55.19	100.40	128.20	129.60	131.50	98.55	86.86	69.31	54.58	37.96	29.12	24.30	21.28	19.05	16.18	13.69	11.83
1934	33.56	51.19	94.42	87.12	116.50	103.10	81.59	94.93	110.40	104.20	61.31	48.70	42.92	34.66	30.02	24.16	22.18	17.27	14.33	12.40	12.16	11.48	9.14
1935	5.85	18.67	16.36	21.56	28.18	37.31	98.54	91.77	81.31	85.02	70.42	58.11	48.59	43.59	44.13	36.64	27.76	19.82	18.02	13.56	12.05	11.64	10.55
1936	13.48	15.02	33.03	33.75	61.71	97.62	66.37	83.94	77.14	57.99	49.67	45.06	32.24	25.78	20.30	18.11	15.09	12.80	10.56	12.81	9.43	9.04	7.95
1937	6.38	8.71	9.71	25.02	40.91	53.50	63.94	73.40	70.77	160.00	125.40	80.99	63.72	40.62	32.00	23.69	19.95	16.37	12.98	10.52	7.56	9.61	9.47
1938	13.31	25.16	32.48	45.64	38.72	65.13	100.50	134.40	111.20	75.63	90.44	84.67	68.85	49.47	38.16	29.65	20.63	14.76	12.86	13.67	12.12	9.77	12.34
1939	10.49	14.92	34.34	66.39	59.38	69.20	58.97	72.83	51.35	43.09	43.58	41.51	39.95	33.57	27.84	20.95	19.15	14.29	12.50	10.62	9.65	9.79	8.14
1940	5.39	11.65	18.48	23.12	37.96	64.84	63.32	67.35	61.20	55.62	47.73	36.02	26.89	21.70	18.38	17.14	17.25	13.05	10.32	8.76	7.99	9.05	9.02
1941	8.15	11.12	14.86	32.94	31.92	41.20	36.25	48.21	49.81	41.26	33.91	33.18	38.27	25.06	20.38	16.06	12.79	10.91	10.08	9.17	8.22	10.48	13.97
1942	12.46	19.32	37.77	27.29	42.95	54.66	67.69	73.76	113.40	66.74	57.70	63.62	71.98	55.65	43.67	37.02	30.63	25.86	20.67	16.97	14.07	12.14	11.76
1943	25.97	50.82	50.98	46.14	38.99	35.05	71.02	110.40	83.61	93.23	145.70	99.94	108.10	85.40	60.18	56.00	36.63	28.64	21.03	16.03	13.71	12.92	10.34
1944	6.01	5.87	4.22	13.46	21.86	38.67	56.68	46.32	49.27	48.18	41.99	41.77	38.31	24.97	16.72	15.54	14.02	11.68	17.37	18.14	13.88	12.81	11.70
1945	4.35	4.62	3.36	15.94	59.17	68.34	60.40	97.54	117.30	78.37	87.30	86.59	56.68	47.89	35.92	26.56	19.72	14.91	12.57	10.13	8.37	14.11	15.44
1946	8.53	20.37	34.52	45.53	54.50	71.84	71.10	97.33	92.79	78.73	72.31	56.34	53.55	52.57	39.56	28.49	23.56	17.03	13.81	12.65	15.94	14.93	15.37
1947	17.75	29.17	39.16	74.41	96.22	78.22	63.48	69.61	76.58	76.09	69.24	70.40	60.13	54.12	41.70	32.36	23.75	19.47	15.32	18.32	17.43	13.52	11.60
1948	5.45	25.81	27.74	34.88	43.15	42.02	143.20	160.40	184.50	137.10	195.30	108.40	69.91	44.64	34.43	31.95	37.07	25.29	19.12	16.23	16.20	11.89	9.10
1949	10.55	14.17	24.51	33.30	41.12	88.70	78.23	96.91	84.45	70.48	43.09	43.04	32.90	31.57	27.56	21.09	19.16	16.00	12.09	10.70	9.13	10.21	10.56
1950	11.74	16.42	15.94	14.88	24.59	73.42	78.77	96.23	114.90	120.40	157.10	138.30	135.10	101.40	70.44	55.59	44.89	33.53	29.25	25.90	25.60	19.79	14.73
1951	17.97	23.45	30.34	67.82	95.44	106.10	111.50	75.76	55.11	96.04	121.40	133.90	120.40	101.80	89.81	61.68	47.29	36.27	28.07	22.02	34.20	36.84	29.18
1952	13.49	31.54	42.66	67.30	52.96	69.24	79.15	70.97	68.78	71.61	58.25	51.30	55.15	42.14	36.67	33.06	28.11	29.67	27.97	18.93	15.42	13.33	12.86
1953	6.91	12.03	41.21	51.23	70.87	56.87	96.65	149.30	219.00	190.40	120.70	76.63	86.12	88.30	74.50	45.27	33.82	30.80	24.89	20.18	16.00	15.38	12.76
1954	13.34	17.09	11.90	12.67	44.07	111.90	171.80	111.40	98.32	101.50	94.94	118.10	109.90	114.10	89.33	57.23	40.54	32.05	27.81	25.03	34.57	25.51	20.52
1955	9.17	8.02	7.90	13.12	17.93	48.61	74.10	64.28	93.07	120.60	103.40	121.10	62.67	72.00	73.40	51.06	36.71	27.17	20.50	16.57	13.45	12.28	11.60
1956	7.29	16.28	27.27	21.77	25.21	48.55	157.10	145.10	136.60	90.13	93.68	70.48	68.23	64.43	58.11	47.37	35.08	28.14	22.05	18.24	19.23	16.17	12.35
1957	4.74	7.01	12.26	57.94	117.20	103.40	114.20	99.83	118.40	96.89	58.24	48.98	39.94	34.19	27.90	21.03	17.63	15.32	13.24	11.42	10.16	8.38	7.10
1958	10.66	13.72	13.64	17.70	68.17	95.58	105.80	100.20	89.79	90.34	73.68	59.18	42.21	37.72	28.17	25.00	23.03	16.90	14.86	13.58	12.06	9.60	8.83
1959	17.37	21.32	25.74	49.87	43.60	66.37	72.28	70.77	138.20	111.20	120.50	100.50	71.98	58.64	61.65	52.06	33.52	24.76	18.73	18.49	22.16	26.01	40.24
1960	25.48	21.00	17.36	17.02	27.54	66.41	39.65	48.21	106.50	85.71	90.86	66.52	63.11	51.23	42.99	33.27	26.64	24.39	17.95	13.40	10.40	11.77	11.82
1961	12.18	13.29	14.34	16.55	27.82	45.44	105.30	143.80	135.40	102.70	99.63	69.00	46.64	40.44	35.95	28.94	21.60	18.65	15.17	13.66	13.05	12.69	10.16
1962	9.82	26.93	47.75	35.64	32.78	51.40	71.69	78.47	62.17	76.58	83.43	67.17	47.05	35.42	30.37	28.29	28.56	26.38	19.32	15.57	13.93	14.26	12.50
1963	8.43	12.48	13.05	27.58	40.66	42.46	63.74	90.63	109.70	114.60	89.50	68.84	70.98	57.98	38.29	28.32	19.83	17.82	17.03	13.18	10.80	9.16	11.95
1964	2.32	6.02	9.18	29.84	36.99	51.42	84.89	72.85	244.60	277.80	127.00	104.80	81.80	73.98	57.38	37.21	29.57	22.53	18.72	14.62	13.56	18.20	16.42
1965	10.95	15.58	36.80	53.66	42.31	65.59	65.43	87.90	103.90	119.60	149.40	101.00	68.77	73.19	53.91	38.77	33.81	29.11	23.94	19.82	17.32	15.65	14.85
1966	23.90	24.07	21.76	22.56	72.88	54.59	57.27	115.20	118.80	99.14	82.84	66.72	66.74	59.82	45.86	32.14	24.51	20.67	16.06	17.07	16.80	13.81	12.02
1967	7.82	7.52	8.87	8.98	28.10	61.50	133.20	143.50	130.80	122.30	133.60	118.20	104.80	77.32	57.58	41.15	33.12	27.09	21.88	18.53	13.97	11.78	11.67
1968	8.00	8.12	8.94	19.13	29.99	43.47	83.09	90.71	108.80	101.80	81.44	75.00	54.46	57.57	41.74	33.18	27.76	22.07	23.63	22.06	17.73	18.61	18.29
1969	20.73	25.54	41.90	34.40	46.82	71.44	60.30	83.15	100.70	73.89	62.91	112.50	77.01	51.14	33.35	26.62	21.86	15.37	12.86	12.08	10.53	8.55	9.01
1970	4.07	5.44	6.22	16.17	55.15	64.88	103.80	106.10	140.30	148.90	139.80	95.07	54.65	44.67	34.89	26.86	24.60	21.53	15.34	12.11	10.52	9.95	11.35
1971	8.98	12.92	34.26	52.00	90.23	90.73	67.47	119.70	118.60	103.70	83.12	103.20	77.28	60.24	61.63	60.32	44.69	40.70	28.02	19.28	18.35	17.00	11.68
1972	21.75	18.60	20.59	32.23	33.11	90.19	125.40	120.50	165.90	149.30	94.87	71.96	65.81	63.78	73.61	60.62	52.68	42.04	34.32	27.48	22.24	18.19	16.32
1973	6.50	7.77	11.46	13.63	21.77	64.22	85.18	59.35	60.61	89.02	56.33	65.87	43.92	33.61	25.90	20.18	17.49	16.69	13.69	11.09	14.10	9.69	8.47
1974	6.76	13.40	30.60	50.69	68.06	47.02	43.25	80.06	98.54	125.90	175.60	138.00	95.61	75.15	67.66	56.30	41.59	33.79	24.62	20.48	19.51	14.62	14.84
1975	3.73	3.56	7.34	12.14	34.09	75.93	66.53	71.96	142.20	128.20	324.70	151.30	124.00	111.90	71.83	48.16	45.25	31.00	22.85	26.05	30.59	25.42	17.31
1976	22.05	28.75	21.83	30.78	80.57	97.28	74.63	70.70	54.39	66.64	66.58	59.18	61.34	69.97	57.54	45.86	36.71	36.21	34.02	32.72	29.70	21.15	15.71
1977	8.16	8.22	15.29	38.60	40.28	41.27	30.29	30.67	49.44	43.95	33.20	27.96	22.72	17.09	18.49	22.18	21.49	16.94	19.29	19.47	21.03	26.33	25.08
1978	14.32	13.79	17.34	40.26	44.87	67.20	82.84	60.81	102.00	94.07	76.05	87.69	81.77	60.05	60.58	44.29	34.73	25.46	23.22	33.16	28.36	24.34	29.41
1979	12.03	14.12	18.29	35.97	47.44	81.19	103.50	101.90	102.30	85.67	72.47	59.93	51.19	43.24	29.31	26.44	19.58	15.49	13.47	13.84	12.96	11.13	11.70
1980	5.73	16.39	50.06	86.25	72.24	51.19	99.72	105.10	67.90	80.06	78.10	53.30	41.62	32.74	28.22	23.48	19.49	16.29	15.50	19.22	13.79	14.70	16.14
1981	7.22	11.28	32.01	61.18	44.33	65.28	132.10	112.50	88.32	68.59	62.27	67.48	66.61	48.56	38.30	38.81	27.67	21.46	19.79	15.82	14.01	11.22	9.06
1982	8.25	7.71	13.26	18.84	22.18	42.26	82.95	72.93	73.61	109.10	126.70	115.30	98.32	59.38	47.27	33.66	32.38	26.41	21.58	17.44	14.01	12.20	11.85
1983	6.72	8.98	21.17	20.84	26.56	25.84	59.27	97.01	72.73	69.27	51.48	46.07	45.89	48.66	51.70	38.82	27.74	24.20	19.43	14.17	14.24	13.34	11.05
1984	5.01	12.07	24.32	17.58	15.02	35.64	58.36	64.89	60.62	50.93	78.54	84.01	63.05	44.19	34.35	26.56	27.69	21.70	16.80	15.53	11.49	9.42	13.71
1985	11.69	25.43	20.70	49.03	48.85	42.35	94.27	95.65	99.05	86.51	63.91	41.74	40.99	34.93	24.60	19.36	15.95	15.13	17.61	17.20	14.77	17.98	34.62
1986	21.97	20.20	36.66	32.15	35.26	31.01	61.39	129.60	100.60	68.54	51.65	44.14	39.22	29.86	26.08	22.25	17.04	15.08	14.13	11.27	10.81	14.19	16.02
1987	14.99	27.17	33.91	76.73	78.10	77.88	46.65	74.43	56.00	54.12	45.61	30.35	27.70	20.86	32.37	81.45	38.35	22.20	22.35	23.11	21.92	17.30	15.27
1988	16.39	33.73	34.52	27.47	39.39	74.05	61.77	67.41	65.55	57.45	50.83	46.32	33.24	22.30	18.43	16.21	12.97	11.35	11.85	9.60	7.76	6.78	5.93
1989	9.25	26.91	44.94	34.41	92.97	68.41	46.63	46.19	103.56	156.43	86.37	64.54	54.46	49.27	56.04	40.17	27.89	21.13	18.30	22.59	48.33	31.56	24.81
1990	19.40	31.37	53.77	39.73	54.24	43.06	54.13	91.94	72.70	72.37	80.57	98.20	80.69	60.41	48.07	41.41	36.87	26.79	22.11	21.74	17.31	14.21	11.54
1991	20.09	17.09	29.04	27.34	32.03	103.46	164.71	99.80	118.86	121.66	135.59	117.71	110.34	76.19	62.39	45.64	37.47	30.89	26.29	19.74	15.09	11.35	10.67
1992	11.77	17.14	21.37	49.73	56.44	35.90	42.53	49.13	45.40	41.59	53.86	43.49	37.21	32.51	26.09	20.21	16.91	14.64	11.07	9.72	14.43	10.39	9.75
1993	13.31	14.26	14.47	17.46	30.63	85.84	84.26	67.89	56.63	50.80	57.89	44.86	59.11	59.79	48.64	41.71	31.16	21.96	26.76	26.30	21.90	22.69	23.33
1994	15.09	27.71	52.20	35.81	59.97	78.40	69.63	72.10	65.64	59.46	48.26	50.59	40.44	27.64	27.63	23.10	19.01	14.43	12.33	9.00	7.78	6.92	4.89
1995	9.79	8.79	11.33	18.01	54.96	69.34	70.24	91.66	230.57	124.43	111.43	97.63	83.34	71.47	53.13	47.19	34.70	28.10	27.57	22.11	15.14	15.79	13.61

Appendix 1. Naturalized weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 6 of 6)

LSTM = St. Mary River at Lethbridge (Station 05AE006)

Week Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	26.11	26.56	27.56	33.06	48.90	71.00	74.10	66.31	61.84	79.99	82.16	74.50	62.26	59.17	38.99	58.56	56.66	33.71	28.13	24.10	21.14	21.83	21.20
1913	40.33	37.43	36.11	35.53	36.61	47.07	89.23	163.10	162.60	135.40	101.60	97.16	89.16	63.70	43.69	42.56	43.01	41.14	39.76	30.64	28.21	23.16	18.90
1914	13.57	24.76	33.63	49.41	55.91	61.56	74.46	66.99	69.09	69.61	69.64	56.73	49.41	57.11	44.56	31.37	29.65	24.24	21.23	28.14	23.89	19.73	17.19
1915	13.76	21.66	28.63	41.96	56.69	76.50	51.27	50.63	107.40	79.96	77.67	89.09	70.83	56.03	46.31	62.06	53.21	35.79	31.60	32.40	26.59	37.13	32.56
1916	23.67	23.07	24.69	32.53	62.94	50.87	65.21	83.34	91.49	115.40	210.30	201.00	187.30	139.30	103.90	71.79	59.01	55.20	45.27	40.94	35.53	40.66	39.67
1917	49.07	25.66	23.13	20.44	22.49	82.31	106.60	133.70	118.30	149.40	143.30	119.00	92.69	86.95	66.20	51.64	36.70	32.17	28.93	23.24	22.04	17.79	16.23
1918	19.50	25.83	28.79	39.36	85.59	76.01	49.11	39.71	51.00	140.00	103.70	64.17	35.73	37.57	34.84	29.69	24.13	23.39	26.13	21.83	18.76	16.03	14.81
1919	9.01	7.56	11.78	38.67	35.53	31.59	75.54	115.70	72.07	51.81	54.99	51.00	36.64	28.14	23.40	18.20	18.51	15.09	14.06	12.04	10.83	11.71	9.98
1920	23.61	36.10	21.80	26.33	61.84	77.17	85.94	63.81	63.34	105.20	124.10	92.47	94.41	73.74	67.63	53.77	36.43	27.80	23.87	19.63	16.76	15.41	17.54
1921	16.67	27.44	30.89	25.53	49.60	62.90	110.90	114.30	123.40	127.40	93.76	94.41	77.29	54.60	43.64	36.81	29.17	22.84	19.91	17.23	14.61	12.80	11.89
1922	4.29	8.64	16.84	45.63	40.49	55.14	110.90	105.60	136.30	118.30	105.60	86.40	64.50	67.20	46.26	40.00	25.84	22.13	17.56	16.87	14.97	13.89	12.90
1923	10.61	13.84	16.81	26.03	40.61	82.34	78.11	98.56	116.90	121.90	102.10	83.09	70.04	51.54	47.89	38.97	29.59	19.47	17.17	28.03	24.97	21.21	18.01
1924	16.79	11.21	10.54	16.13	34.64	78.47	85.14	71.11	85.17	116.00	121.60	83.60	78.44	62.99	36.91	26.80	26.40	26.06	24.14	21.27	19.77	13.84	13.53
1925	44.99	57.26	50.97	56.49	65.84	104.10	162.70	126.70	90.29	90.70	109.70	109.40	79.04	57.76	46.06	33.81	30.01	23.67	22.19	23.00	17.26	17.24	14.06
1926	6.49	26.09	35.14	44.33	41.01	26.88	30.79	24.00	23.26	25.19	37.13	37.46	31.21	25.70	19.80	15.23	14.37	12.60	11.24	10.21	10.97	24.24	30.24
1927	8.55	15.64	40.31	62.04	52.29	79.29	167.40	195.40	161.30	203.40	176.00	165.00	113.60	92.93	76.94	62.77	51.96	37.53	37.39	44.93	29.64	36.90	63.47
1928	16.17	19.09	27.29	42.30	80.60	124.10	145.00	141.90	82.41	64.61	95.11	133.10	158.40	91.01	79.26	57.67	52.37	35.84	25.79	19.64	28.61	22.00	17.57
1929	12.56	16.89	22.21	26.13	32.99	58.10	93.57	89.40	104.90	100.50	65.14	46.03	52.06	47.00	33.66	25.89	20.63	17.19	14.39	11.53	10.27	11.34	8.57
1930	34.80	42.94	56.47	81.54	75.07	59.20	80.61	76.34	84.00	83.37	60.33	58.51	44.79	38.69	35.16	28.46	19.66	16.54	16.03	12.94	10.44	8.45	10.03
1931	6.05	6.32	7.84	21.38	43.01	76.91	57.66	65.60	66.64	53.56	43.41	35.29	26.93	23.34	20.79	17.26	25.54	20.46	14.43	12.59	10.70	11.07	13.09
1932	14.24	19.86	35.24	25.03	52.01	95.16	120.80	73.10	76.61	78.44	98.81	83.17	66.47	46.06	32.71	27.27	23.04	18.14	16.40	16.51	15.54	11.20	11.33
1933	7.65	11.52	20.33	38.77	53.11	57.54	59.10	103.10	141.60	136.70	141.30	99.41	87.06	72.76	55.31	39.47	[illegible]	25.00	21.84	20.93	17.03	13.84	11.20
1934	34.59	51.39	98.17	92.38	122.70	107.70	89.04	98.30	116.40	127.50	72.07	55.30	48.39	37.53	27.54	25.19	22.57	17.73	14.73	12.87	11.69	11.90	10.13
1935	5.42	32.51	19.49	24.80	31.39	35.47	93.44	93.13	84.03	85.67	74.89	59.53	50.90	44.64	44.10	37.53	28.97	20.51	18.40	14.20	12.66	11.60	10.47
1936	29.25	16.93	32.67	34.14	59.34	96.07	71.07	76.30	89.21	59.31	52.97	45.21	34.10	24.90	19.53	17.11	14.04	12.40	10.27	12.03	10.59	8.75	8.76
1937	16.17	12.69	12.56	25.41	43.37	54.14	69.94	79.63	76.86	172.90	131.40	89.21	65.93	43.04	32.70	24.99	21.11	18.04	14.11	11.37	8.52	9.39	10.43
1938	25.10	25.40	35.51	48.21	43.77	66.47	104.20	140.10	123.60	80.97	91.76	89.71	75.40	54.09	40.51	31.76	22.50	15.61	13.33	14.16	12.57	10.70	12.27
1939	10.35	13.13	32.94	62.76	63.67	66.34	65.11	71.57	56.00	48.07	47.29	41.07	39.14	31.91	27.79	19.43	18.66	13.91	12.13	10.40	9.10	8.94	8.29
1940	6.88	12.28	24.73	28.30	40.09	65.31	63.29	67.10	60.70	54.99	49.03	38.29	26.69	22.30	17.70	16.33	18.70	13.69	10.18	8.89	8.05	8.03	8.97
1941	8.07	12.44	13.67	31.56	35.66	39.93	40.50	52.20	60.41	45.10	36.40	33.96	41.89	27.56	21.57	16.96	13.61	10.35	10.15	9.19	8.88	9.94	13.40
1942	15.70	22.43	37.14	30.10	42.36	63.96	68.33	84.44	138.00	104.00	68.50	73.80	75.13	60.81	47.27	40.91	37.96	30.10	23.17	17.73	14.26	12.91	11.73
1943	31.83	51.27	57.89	52.03	45.14	39.11	68.87	119.40	102.70	102.60	158.00	121.70	124.70	102.20	66.79	61.46	43.03	31.54	22.07	16.74	14.21	12.71	10.92
1944	8.13	6.20	4.29	8.97	18.64	31.76	59.07	42.90	48.73	47.29	43.83	42.87	41.21	28.53	16.99	15.01	13.43	11.63	15.33	18.74	13.61	12.49	10.60
1945	5.14	5.41	4.78	11.86	52.91	72.26	59.43	94.99	142.00	102.10	92.76	107.60	88.84	50.00	37.56	26.51	19.97	15.23	12.97	10.41	8.58	11.27	15.84
1946	7.45	18.07	33.63	46.40	54.96	70.90	71.94	101.30	99.53	80.61	72.76	62.57	53.93	54.51	43.16	29.70	23.63	17.61	13.59	12.13	15.37	14.64	15.76
1947	20.20	32.31	40.21	71.24	100.30	88.57	68.51	72.50	78.99	82.97	73.04	72.89	61.01	55.16	44.60	33.60	24.10	19.74	15.17	17.08	19.83	19.06	16.14
1948	9.01	66.59	45.34	40.69	66.01	56.07	147.10	172.10	196.30	153.60	210.30	113.70	73.69	51.61	36.94	35.06	38.46	27.99	21.84	17.17	16.30	13.00	9.96
1949	17.04	15.80	24.64	33.07	35.17	87.03	87.33	100.60	87.77	76.74	50.31	44.31	34.83	32.51	29.57	21.53	19.29	16.11	11.94	10.46	9.25	9.33	9.97
1950	18.39	26.19	21.70	18.06	27.51	78.27	83.21	101.30	121.70	127.70	159.70	150.60	141.10	109.30	76.39	59.49	49.80	38.47	29.63	25.99	26.56	19.27	15.29
1951	31.33	29.84	35.89	103.20	113.40	140.70	127.70	87.81	73.60	106.60	128.60	223.90	153.40	134.50	108.20	70.97	54.47	44.43	36.19	26.11	56.09	57.44	40.71
1952	30.80	43.49	50.81	70.30	86.40	74.27	85.40	78.27	69.06	80.13	65.06	54.13	59.93	45.96	43.26	38.93	27.64	32.29	32.34	21.86	19.93	16.93	16.13
1953	10.30	16.87	64.64	70.67	77.37	57.56	100.40	184.10	334.00	216.40	140.40	78.37	82.96	104.40	71.41	50.73	39.31	36.29	40.74	17.47	14.96	13.67	14.81
1954	24.97	24.97	14.51	13.46	49.19	117.50	184.40	120.10	105.40	105.00	95.74	126.60	117.90	116.90	97.66	62.79	41.97	33.73	30.26	26.99	37.46	30.26	26.11
1955	24.53	10.24	13.39	18.19	26.17	69.26	111.10	82.74	104.10	136.70	110.10	131.40	63.66	77.21	78.06	59.90	43.99	30.31	23.14	16.57	14.57	10.07	13.16
1956	9.79	18.90	30.46	26.91	32.66	47.80	150.60	158.30	133.00	93.23	100.60	71.67	85.96	62.70	66.86	53.44	38.03	31.10	25.84	19.23	21.21	18.06	12.43
1957	5.55	10.77	17.04	51.80	127.00	112.90	125.40	107.70	121.40	103.90	52.47	42.64	45.20	39.57	32.76	26.84	15.43	13.36	14.71	13.73	12.30	9.22	9.57
1958	36.99	21.34	18.30	19.76	60.37	108.40	104.80	105.30	97.21	103.00	83.80	64.93	48.11	42.39	31.96	29.37	25.41	18.30	15.96	15.60	11.16	7.90	9.49
1959	29.29	29.99	32.77	56.13	51.69	68.64	82.89	78.10	135.10	108.30	125.90	114.80	70.46	61.59	65.39	52.97	37.59	27.01	19.26	21.84	21.89	22.01	39.39
1960	31.11	26.17	22.03	24.56	34.97	73.59	49.34	48.59	102.40	91.64	93.49	69.19	65.99	52.81	44.76	35.80	29.26	29.01	16.37	13.40	12.39	12.36	14.87
1961	13.30	12.91	14.47	16.13	29.73	50.87	103.40	155.40	138.70	109.90	103.10	74.50	49.19	41.76	37.06	31.34	22.91	19.59	16.94	14.70	14.50	15.37	8.13
1962	13.24	26.57	53.01	43.04	33.76	52.99	75.03	81.64	69.43	79.36	87.36	71.74	52.64	37.04	31.07	29.31	27.73	30.44	22.03	15.33	13.13	13.95	13.39
1963	11.89	15.27	15.84	23.47	43.56	40.66	59.17	87.63	108.90	119.90	102.10	86.50	79.53	54.23	36.89	32.73	22.40	19.40	17.63	12.69	10.44	5.46	8.75
1964	8.86	9.21	17.11	71.26	78.57	88.36	94.09	77.16	258.20	353.10	135.70	106.80	82.60	80.53	61.00	41.44	30.97	25.00	19.47	15.33	13.14	19.87	18.91
1965	26.54	25.59	44.97	68.64	47.86	72.43	77.20	95.81	111.40	124.40	175.30	136.00	81.29	92.77	65.16	51.67	31.97	33.40	26.11	20.39	18.46	15.86	16.26
1966	27.37	27.53	25.89	23.93	72.63	84.41	54.74	111.40	169.10	110.90	84.80	75.41	78.00	67.36	51.41	35.64	26.40	21.90	17.40	20.64	21.73	15.97	12.68
1967	15.40	14.47	12.79	20.09	101.90	114.10	156.40	153.60	151.30	148.70	149.60	121.00	109.60	87.03	70.06	47.93	34.67	29.99	20.14	22.67	12.81	11.42	11.56
1968	9.79	11.61	12.41	21.67	35.29	40.86	88.94	93.74	114.40	110.50	77.04	77.71	65.44	60.69	43.83	37.36	32.31	24.47	22.89	30.60	19.57	20.99	19.21
1969	35.39	32.07	48.97	40.89	50.33	79.04	64.84	92.69	112.00	89.19	65.76	153.80	88.46	48.70	30.73	30.77	28.46	16.91	10.40	7.08	5.48	8.98	9.41
1970	8.11	7.09	6.65	16.50	53.86	75.41	108.90	115.80	142.90	172.00	155.30	104.20	59.24	48.34	39.46	30.93	30.39	20.33	14.44	13.15	9.33	8.53	12.56
1971	12.03	14.20	35.40	52.27	97.24	87.63	73.53	134.70	131.60	107.90	82.71	104.00	78.54	65.33	63.19	59.31	48.93	41.34	27.74	20.17	18.01	18.51	9.89
1972	33.99	24.43	24.40	38.59	41.56	93.21	142.40	141.40	181.40	176.40	107.30	76.97	70.87	67.56	81.13	72.04	56.59	48.56	37.34	31.19	23.97	19.67	18.86
1973	8.56	10.26	15.04	16.63	24.53	62.09	94.51	61.14	74.20	96.41	62.24	62.81	47.47	34.17	26.47	20.83	18.14	16.61	12.66	9.83	11.10	11.24	5.64
1974	11.09	16.13	37.19	70.31	72.24	55.71	42.11	77.11	111.30	121.40	174.00	134.00	97.44	78.86	68.27	57.79	44.63	32.16	30.09	24.06	20.99	14.83	15.80
1975	3.12	11.50	78.40	55.23	78.44	90.14	81.36	71.00	143.70	127.00	415.70	166.10	131.90	136.40	82.10	49.89	49.50	32.07	20.33	25.21	30.54	29.60	23.01
1976	24.30	30.64	24.86	35.63	79.91	108.40	90.07	75.13	60.71	70.14	69.53	69.66	60.40	69.29	60.64	49.63	37.71	46.26	34.89	30.67	31.53	19.23	20.44
1977	12.39	7.82	11.37	28.86	36.67	39.23	29.01	26.71	42.59	42.13	29.50	21.79	20.40	14.40	15.11	16.40	19.94	13.19	16.41	18.04	18.10	25.00	23.43
1978	14.86	17.40	17.73	39.76	53.16	71.87	85.61	71.54	96.19	101.60	77.73	92.77	89.07	67.27	65.41	49.29	36.11	27.63	21.60	37.19	36.81	24.39	36.44
1979	32.91	30.54	32.69	46.60	67.24	69.63	106.00	121.60	101.60	90.41	78.69	62.34	52.70	42.89	33.70	26.84	23.09	17.88	14.30	13.37	13.99	11.66	10.13
1980	9.72	24.40	48.63	65.60	75.60	51.11	87.40	148.70	84.47	104.30	98.87	53.69	43.60	34.77	26.29	25.87	16.41	12.52	14.06	19.51	14.66	12.47	13.78
1981	8.36	11.55	29.16	56.34	58.27	103.90	193.70	101.90	93.36	113.80	71.73	69.83	69.53	52.49	37.23	42.33	29.13	23.46	18.24	14.91	10.60	9.76	8.23
1982	49.34	26.69	19.27	17.20	23.31	36.97	76.46	91.30	80.21	105.60	126.70	117.30	98.11	69.16	48.86	41.76	33.34	28.73	21.66	15.16	12.83	11.83	6.74
1983	2.96	8.66	19.24	21.06	27.37	27.73	53.54	96.56	74.73	68.41	49.24	43.91	44.39	45.83	55.19	39.14	27.14	20.70	15.08	13.10	13.36	10.49	11.38
1984	5.90	10.09	24.36	18.20	13.73	28.63	51.63	56.49	56.76	48.16	69.20	80.71	65.57	44.69	31.16	25.24	24.03	20.03	15.90	12.85	7.97	6.88	9.91
1985	11.36	24.71	23.83	40.34	51.27	40.94	81.20	93.36	92.41	89.00	64.71	42.19	37.64	32.04	23.99	16.17	15.61	9.58	17.13	17.94	13.02	17.03	38.07
1986	21.50	24.13	35.73	34.94	42.19	34.87	66.06	124.00	111.60	70.80	58.61	41.20	38.07	28.10	26.21	20.27	19.09	13.14	13.01	5.52	9.38	10.56	14.01
1987	19.09	28.51	35.34	70.77	75.90	79.94	47.94	79.43	55.86	55.44	51.13	36.79	37.60	25.17	28.87	91.36	43.69	28.06	25.73	26.87	28.34	17.36	16.57
1988	14.11	31.41	37.37	28.07	38.71	69.63	59.57	64.03	62.63	62.64	50.11	42.49	30.51	18.13	13.86	8.07	8.56	8.01	8.49	8.53	3.63	2.35	5.09
1989	15.84	26.93	44.70	39.60	65.60	72.51	50.29	48.36	105.59	175.86	92.39	66.93	55.37	46.71	56.90	41.59	28.66	23.13	17.14	16.14	46.61	39.60	28.09
1990	24.29	35.69	60.64	51.37	56.60	49.40	56.69	109.66	81.27	79.23	80.09	96.13	82.54	65.67	48.29	45.01	39.39	28.89	23.10	17.45	20.79	15.70	8.07
1991	23.97	19.19	32.01	28.93	40.51	96.91	175.14	108.14	121.88	122.79	156.89	139.57	122.14	86.99	65.61	48.27	39.63	33.66	35.24	19.71	15.94	10.19	9.34
1992	10.04	16.67	19.66	41.04	49.37	34.53	34.04	45.13	42.30	34.67	61.86	52.26	49.97	40.69	29.40	28.01	21.39	13.64	14.46	9.59	15.88	10.10	8.78
1993	23.09	19.74	21.16	19.27	34.69	84.01	85.90	63.89	62.03	68.19	65.79	50.03	64.51	94.64	72.59	62.49	41.16	27.76	41.04	35.46	25.44	29.76	32.24
1994	19.90	30.04	55.94	45.30	63.29	83.19	97.80	77.56	71.49	60.74	54.54	48.71	41.37	29.84	29.31	21.40	15.57	16.46	10.69	2.34	2.35	2.35	2.35
1995	3.58	9.80	13.26	19.73	116.21	101.56	96.54	105.94	349.29	157.88	128.57	118.59	122.43	79.56	57.86	57.93	41.53	28.93	25.93	24.84	14.30	15.11	16.73

Appendix 2. Actual weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 1 of 6)

UBEL = Belly River at Mountain View (Station 05AD005)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	5.81	6.02	6.61	7.52	11.86	25.37	24.14	21.29	17.27	23.40	20.06	21.33	17.06	16.76	14.70	17.80	12.13	9.76	7.69	6.62	6.29	5.53	5.63
1913	4.30	6.05	11.33	7.46	9.26	14.14	29.76	55.17	47.04	39.97	29.86	38.10	24.74	19.26	12.17	14.81	13.07	16.51	12.37	8.51	8.10	6.94	5.50
1914	4.24	10.03	12.46	17.34	17.34	27.57	26.86	25.79	23.73	28.14	24.56	18.16	21.04	18.13	12.86	9.90	9.48	7.56	7.96	8.67	6.09	4.69	4.64
1915	5.33	11.28	6.99	16.17	20.60	17.67	14.03	20.14	30.06	24.34	24.11	28.31	22.51	15.67	14.40	14.90	14.89	11.69	10.15	9.38	8.51	10.12	8.62
1916	6.35	7.55	7.62	13.39	21.96	11.11	15.44	17.41	28.06	40.04	62.37	49.47	45.06	43.81	29.79	19.97	14.83	15.81	14.70	11.81	10.73	15.44	9.00
1917	2.77	2.78	2.91	4.01	13.82	32.26	35.46	34.80	45.29	46.04	40.80	32.31	32.73	28.40	23.44	15.41	9.16	8.40	7.92	7.99	6.19	4.56	4.58
1918	7.05	8.31	10.13	23.40	22.74	21.91	11.40	13.93	26.31	41.59	27.47	18.09	12.80	13.17	11.73	9.74	9.00	6.30	9.09	6.88	7.02	6.33	5.95
1919	3.15	5.22	7.69	15.43	10.37	13.52	41.28	36.40	19.59	15.81	20.31	17.69	11.54	10.79	9.55	7.97	7.70	7.10	5.91	5.72	4.32	3.72	2.96
1920	1.96	2.07	3.27	4.34	12.33	24.26	25.96	16.87	27.79	45.31	43.80	29.37	37.27	29.40	26.66	18.46	14.59	11.19	10.18	7.19	6.37	5.03	6.76
1921	6.48	12.07	8.66	8.21	20.16	23.59	45.40	33.97	42.63	38.83	30.06	30.27	23.79	18.74	15.60	13.01	11.03	8.50	8.06	6.62	5.66	4.93	4.10
1922	2.05	3.19	5.11	12.20	11.40	30.74	37.61	36.20	45.56	37.69	33.17	25.17	24.43	24.53	14.23	10.63	9.83	8.71	6.76	6.34	6.06	5.27	4.05
1923	2.58	6.36	7.05	8.13	19.41	19.34	30.51	43.19	51.06	38.39	31.19	27.49	21.30	17.29	15.94	12.86	9.63	6.91	7.11	13.77	8.16	6.18	4.66
1924	2.99	3.31	3.56	9.79	17.46	33.09	22.87	20.46	33.03	38.64	32.06	23.46	26.06	16.86	12.16	10.84	10.01	10.87	10.63	8.59	7.45	5.84	5.05
1925	14.90	15.61	10.31	14.65	18.46	40.70	53.13	37.69	23.99	29.91	38.56	32.60	22.71	17.66	14.41	11.47	10.09	8.14	8.95	7.97	5.98	6.10	7.19
1926	4.44	15.94	11.16	16.16	9.79	8.93	8.63	6.96	8.78	8.28	14.56	13.09	10.28	8.99	6.84	5.82	5.36	4.70	4.31	4.28	6.77	13.87	11.40
1927	2.40	4.63	17.74	17.73	11.48	28.99	28.53	38.96	58.46	64.00	57.33	48.10	34.91	29.87	27.94	22.39	17.56	13.81	17.93	14.09	10.93	10.73	24.13
1928	3.45	2.96	8.17	13.80	27.66	37.21	48.64	34.84	22.01	24.81	37.51	47.66	42.07	25.47	20.34	17.43	14.60	10.53	8.52	7.13	8.49	7.20	5.47
1929	2.22	2.51	4.86	8.34	9.95	22.24	34.17	28.04	33.59	30.17	16.67	15.39	18.34	16.96	12.76	9.26	7.72	6.53	5.50	4.36	4.65	3.89	2.84
1930	13.84	14.71	25.16	27.43	18.94	19.84	29.30	27.57	29.94	25.59	21.33	18.66	16.03	15.47	12.93	9.77	8.09	7.43	6.31	4.93	4.37	3.92	4.69
1931	2.24	2.68	4.27	14.85	15.99	27.91	16.64	21.19	18.49	14.44	13.44	10.07	7.74	7.72	7.27	6.32	8.74	5.74	4.30	3.95	2.68	3.17	3.35
1932	5.04	5.78	5.88	8.00	26.73	34.40	34.67	21.33	27.17	31.10	30.29	27.00	19.76	13.40	11.46	9.78	8.36	6.77	6.06	6.60	4.90	3.37	3.14
1933	2.00	1.94	8.48	12.39	14.06	19.91	23.39	43.66	46.03	47.21	36.81	29.36	26.66	21.50	15.77	12.43	9.87	8.64	7.32	6.43	5.32	4.29	3.83
1934	14.96	21.66	37.17	27.43	35.87	33.73	25.90	30.97	50.36	36.90	21.01	19.07	17.23	13.29	11.31	9.29	8.44	6.37	5.33	4.65	3.86	3.63	3.34
1935	2.63	4.46	5.84	7.38	9.50	16.07	35.76	28.81	25.51	25.54	21.63	18.81	15.27	14.01	14.67	12.73	9.45	7.15	6.46	4.63	4.28	4.74	3.77
1936	4.57	12.62	11.60	12.93	24.73	32.10	17.81	28.89	22.33	18.16	14.33	13.21	9.38	7.57	7.03	6.33	5.32	4.56	5.20	4.10	3.07	3.69	3.26
1937	1.97	3.72	5.26	11.60	13.31	18.61	21.51	24.29	24.17	72.16	38.94	25.94	19.26	12.31	11.44	8.50	7.43	6.71	4.23	3.59	2.97	3.42	3.20
1938	2.91	13.73	10.18	16.63	14.43	27.59	40.09	47.26	35.30	29.59	34.09	27.13	24.36	18.11	13.90	10.97	7.81	5.62	4.30	3.56	4.09	3.48	3.27
1939	3.55	7.69	18.16	24.37	16.59	22.14	14.53	21.31	13.61	16.17	16.24	14.40	13.74	11.16	7.47	6.42	6.78	4.48	3.58	3.00	2.67	2.71	2.86
1940	1.80	4.78	6.90	11.25	18.16	21.29	22.39	21.23	16.97	19.41	16.39	11.62	9.23	7.66	6.62	8.46	7.93	4.36	3.59	3.06	2.78	2.85	2.86
1941	4.58	5.53	8.26	13.91	9.89	13.63	12.26	15.44	13.40	11.71	8.65	16.18	14.17	8.06	6.70	5.39	4.96	4.41	3.91	3.34	3.47	3.62	6.09
1942	6.26	10.88	14.21	8.37	21.60	17.20	31.77	25.00	48.87	24.36	16.56	36.40	25.47	17.44	12.73	10.80	9.77	9.08	7.40	6.61	5.49	4.99	5.53
1943	10.35	21.86	13.70	11.69	10.87	11.26	33.04	33.16	22.04	33.17	43.34	34.83	33.83	29.26	19.67	17.90	13.06	10.05	7.44	5.78	4.47	3.94	3.03
1944	2.37	2.25	2.17	6.26	7.90	17.24	16.34	16.89	15.86	14.64	15.47	17.47	12.72	7.42	6.01	5.37	4.56	3.79	6.04	4.68	3.94	3.60	3.01
1945	1.40	2.40	3.10	11.01	24.31	21.01	21.80	38.03	38.41	24.59	36.70	29.04	21.11	17.20	12.26	10.10	7.69	5.73	4.22	3.11	2.41	6.66	5.63
1946	6.11	10.48	21.99	19.30	20.46	28.83	27.06	34.09	33.01	27.31	27.44	19.70	20.61	18.19	12.96	9.88	7.67	5.74	4.61	4.54	4.36	4.34	4.60
1947	4.12	8.73	18.39	33.96	36.57	24.86	20.31	23.41	26.86	27.17	24.70	24.36	21.17	19.14	14.50	10.96	7.92	6.48	4.70	7.18	5.74	4.14	3.46
1948	1.76	7.22	9.86	10.66	13.46	17.70	58.39	51.87	58.63	47.64	59.17	35.79	24.16	14.97	13.93	13.23	19.51	10.13	7.44	6.41	5.69	4.61	3.17
1949	3.76	5.44	8.37	9.45	16.67	29.56	28.50	32.34	28.23	21.29	14.70	15.43	12.10	12.93	10.82	7.76	6.58	6.81	5.14	4.99	4.13	4.43	4.36
1950	2.51	4.50	5.01	4.07	8.68	27.90	25.66	30.50	40.34	44.40	52.69	39.56	40.40	28.04	22.04	19.07	15.03	10.96	9.42	7.85	6.79	5.31	2.69
1951	5.24	7.40	9.50	20.86	34.36	34.21	38.19	20.67	16.59	39.89	37.34	43.84	42.44	35.44	32.19	22.09	17.01	12.39	9.40	6.08	14.59	14.36	9.94
1952	3.69	10.66	17.04	21.63	13.99	23.19	25.04	20.04	21.23	21.66	17.70	16.74	17.71	13.37	12.81	10.81	9.58	13.43	11.15	6.47	5.20	3.85	3.61
1953	2.03	3.27	14.37	15.26	23.86	20.03	33.90	52.01	76.04	62.39	35.86	28.27	31.93	36.61	25.89	16.01	13.46	12.41	9.34	6.25	4.24	5.11	4.48
1954	3.12	5.10	3.91	3.69	15.85	43.54	49.90	32.90	31.17	35.67	33.16	39.44	38.51	37.17	20.50	18.00	14.66	12.29	10.54	9.88	13.89	8.98	6.49
1955	3.24	2.62	2.73	4.39	7.50	15.80	24.63	23.17	37.27	45.70	41.34	40.46	21.41	30.03	26.19	17.17	12.94	10.12	7.75	6.57	4.02	3.90	3.10
1956	2.72	7.70	9.08	5.38	7.75	23.02	53.61	45.04	38.14	28.44	27.13	19.70	22.07	24.21	20.40	16.03	10.07	7.33	8.94	7.29	6.59	4.24	3.25
1957	1.53	2.30	5.27	27.20	35.67	43.11	38.09	36.24	39.69	25.09	16.61	14.67	11.47	12.54	9.86	7.94	5.37	4.64	2.45	3.28	2.43	2.19	2.13
1958	3.29	5.87	4.76	9.03	31.11	30.14	37.39	27.14	31.46	30.40	25.93	22.06	14.60	15.00	11.94	10.95	9.83	7.41	4.30	4.54	5.20	3.79	4.38
1959	6.07	6.43	7.27	17.93	13.21	24.74	24.04	26.46	45.63	37.20	38.64	27.14	22.71	19.99	18.26	13.97	7.82	8.55	6.25	7.01	6.26	9.23	10.94
1960	10.77	6.53	5.00	5.73	15.04	25.47	12.94	21.66	34.31	27.49	22.29	20.30	18.41	14.73	12.51	8.21	8.15	8.36	7.12	3.86	3.74	5.36	3.77
1961	3.87	3.93	2.37	3.58	8.67	14.66	42.37	45.94	41.39	29.51	28.56	17.43	11.90	12.11	10.80	8.56	7.40	7.35	3.81	3.17	4.47	3.85	2.59
1962	4.45	11.78	17.76	10.10	10.71	19.77	25.50	26.21	18.73	26.54	24.99	19.21	11.08	9.59	8.19	9.88	9.93	8.21	4.61	5.01	3.65	1.77	2.50
1963	3.09	3.59	3.22	7.99	11.51	12.66	22.54	29.01	35.77	39.36	29.21	24.71	28.09	19.30	10.68	7.07	5.34	5.21	4.45	3.84	2.96	2.12	2.51
1964	2.41	2.79	2.94	11.32	14.03	23.16	31.73	26.14	115.23	75.36	40.50	38.13	30.04	26.19	19.31	9.48	7.45	6.16	5.08	4.97	3.74	3.14	2.09
1965	2.69	4.31	12.01	18.09	14.91	25.11	19.93	35.90	37.29	45.01	51.63	39.24	29.84	26.63	20.70	15.20	11.49	9.32	7.40	5.97	4.33	4.83	6.52
1966	8.34	7.37	6.94	10.69	29.69	15.31	23.37	44.54	40.77	32.90	27.71	23.86	22.13	19.44	14.83	10.29	8.18	6.48	5.12	6.08	7.93	3.51	2.86
1967	2.49	2.52	2.37	3.12	9.56	21.86	49.49	44.34	42.09	40.77	48.64	43.69	37.16	25.99	19.04	13.51	10.09	6.61	5.82	4.55	2.53	2.14	4.25
1968	2.76	3.05	2.97	7.66	9.28	13.64	30.90	30.37	35.63	31.07	24.94	22.33	18.94	21.39	13.27	11.22	9.70	6.66	7.76	8.47	6.81	7.20	6.96
1969	7.39	9.37	15.69	10.50	19.31	26.23	22.81	26.89	35.76	20.69	24.07	44.37	23.00	16.96	12.03	10.32	8.34	4.68	4.69	3.95	2.59	1.53	2.32
1970	2.46	1.89	1.76	5.14	17.09	24.64	36.60	29.86	47.80	61.34	50.29	31.69	19.10	14.36	10.26	9.78	6.03	5.01	3.26	2.67	2.51	2.26	2.05
1971	3.17	4.35	12.67	18.50	31.59	26.03	24.06	41.71	39.09	31.64	28.64	30.57	23.76	20.06	20.03	17.31	14.70	12.46	7.25	4.53	4.31	3.29	2.06
1972	6.76	5.21	5.67	10.47	10.08	37.81	41.87	49.69	58.59	47.77	31.47	25.84	23.49	22.33	21.61	23.91	19.33	15.64	12.38	9.73	8.37	5.96	5.83
1973	2.61	3.37	4.31	5.29	9.77	29.76	24.67	15.79	24.53	22.80	15.36	18.04	11.94	9.26	6.43	5.23	4.84	4.30	3.36	2.31	1.96	2.19	2.20
1974	3.18	5.32	14.00	17.83	25.21	13.17	17.35	28.94	33.23	49.04	57.16	43.53	29.40	22.33	23.61	17.01	11.78	6.92	7.78	5.75	5.49	3.99	5.11
1975	1.18	1.33	3.20	3.96	15.38	31.66	20.28	33.16	53.41	45.99	135.39	49.47	55.54	48.51	25.37	19.23	16.70	10.05	8.02	10.93	10.54	8.72	5.16
1976	8.40	8.89	6.14	11.37	34.64	32.69	26.07	22.80	15.61	21.66	24.83	20.57	22.96	23.33	16.59	14.56	13.39	14.39	11.57	9.07	7.42	5.87	4.32
1977	3.94	3.91	7.53	11.36	10.07	9.88	7.80	8.38	14.54	9.42	7.43	6.52	3.96	2.82	3.53	5.03	5.04	4.17	7.67	7.51	8.41	9.03	5.63
1978	4.29	3.96	5.83	16.30	15.73	23.91	27.87	21.29	41.50	28.34	24.50	27.24	25.60	18.74	24.54	15.96	11.44	9.36	8.37	11.53	8.18	7.47	12.13
1979	2.79	3.48	4.85	12.63	13.81	24.24	41.40	30.99	32.80	24.30	18.74	16.86	14.20	10.85	7.79	8.66	7.14	6.27	3.22	5.38	5.17	3.18	2.25
1980	1.71	8.36	21.03	31.61	21.87	14.17	38.44	36.59	21.53	36.11	26.93	15.53	13.33	12.34	10.55	6.93	5.68	4.47	6.04	8.28	5.40	5.11	4.98
1981	3.22	4.77	16.92	24.61	14.04	25.11	53.50	36.27	27.56	22.26	21.57	23.49	23.69	15.81	14.20	13.27	10.45	7.59	6.51	4.71	4.04	3.05	2.38
1982	0.98	1.77	4.08	6.79	6.86	15.76	27.50	19.74	27.31	39.47	38.23	33.61	25.24	18.19	14.60	12.24	9.78	6.54	5.04	4.03	2.63	2.43	2.82
1983	1.95	3.20	9.67	7.19	10.03	10.04	28.01	33.14	23.21	20.94	16.27	15.47	13.46	16.20	14.79	10.34	8.85	6.71	4.44	2.64	2.14	2.06	1.22
1984	1.73	7.56	9.72	5.49	5.01	14.80	19.00	24.97	17.76	16.50	23.54	24.43	16.44	11.49	9.15	6.91	8.14	6.20	4.74	3.30	2.00	1.65	3.69
1985	7.08	11.28	7.78	21.59	13.91	16.50	35.46	25.56	28.57	21.26	18.37	12.03	13.74	10.57	5.78	4.39	3.43	3.14	8.87	7.91	6.35	5.05	14.34
1986	8.12	6.98	15.99	11.29	12.06	12.47	26.47	47.53	27.43	20.93	15.71	13.30	10.60	7.41	5.75	5.02	3.96	3.83	3.03	1.53	2.09	3.43	5.39
1987	6.65	12.69	14.06	26.29	26.74	20.37	13.60	24.73	16.11	15.20	13.24	9.38	7.33	6.89	14.86	23.34	10.68	7.23	8.85	8.95	8.59	6.55	4.52
1988	7.60	13.73	9.54	8.52	16.01	24.07	18.37	18.61	19.51	14.89	14.91	12.56	8.12	5.70	3.39	2.87	2.46	1.43	1.47	1.65	1.28	1.64	1.06
1989	4.47	11.22	13.81	13.06	31.66	18.06	12.43	16.60	35.51	44.01	21.33	19.07	15.21	13.54	13.71	9.21	6.27	4.76	4.50	9.03	16.27	11.33	9.79
1990	6.72	12.61	19.04	13.20	19.23	14.27	21.23	31.21	20.86	22.90	28.19	31.16	22.89	18.86	13.76	16.09	11.11	7.54	6.12	5.77	4.14	3.55	2.28
1991	8.16	6.67	13.43	9.64	13.60	41.13	45.91	33.24	36.03	31.31	48.31	36.67	33.77	22.40	19.50	12.94	10.48	9.02	7.95	7.11	4.69	3.03	2.31
1992	2.82	5.94	6.07	14.48	13.68	6.19	9.34	10.93	9.08	13.34	16.47	13.00	14.47	12.94	10.05	8.19	7.25	5.76	3.87	4.37	5.30	4.21	3.81
1993	4.94	5.37	6.41	7.71	14.99	31.33	23.64	19.44	14.43	20.53	22.91	15.43	20.66	21.77	17.90	20.03	15.16	10.32	11.65	11.35	11.09	11.14	10.18
1994	4.65	11.62	16.33	10.61	24.46	23.47	23.76	23.47	20.33	17.96	14.83	14.76	11.39	9.04	7.77	7.26	4.83	3.67	3.25	2.46	1.76	1.52	1.35
1995	4.15	4.31	5.53	8.44	22.81	31.24	24.73	41.20	89.01	52.19	50.39	41.71	36.44	30.51	23.49	22.20	14.77	13.39	10.21	7.64	5.65	5.38	4.63

Appendix 2. Actual weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 2 of 6)

LBEL = Belly River at Standoff & Glenwood (Stations 05AD002 & 05AD041)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912		8.81	8.17	8.13	11.04	34.19	37.40	26.21	22.07	23.79	24.53	26.26	22.76	16.87	17.89	20.07	15.17	11.31	8.35	7.28	6.12	4.95	5.04
1913	14.82	16.94	15.01	10.85	11.33	17.93	29.59	65.54	51.17	41.91	29.57	37.29	26.53	20.20	13.56	16.70	15.67	16.73	13.54	9.53	8.26	7.65	5.94
1914	6.37	14.09	16.14	21.30	19.01	26.77	27.84	24.04	27.46	26.29	26.37	19.66	21.57	18.17	14.09	12.20	10.15	8.30	8.54	11.16	6.67	5.48	4.63
1915	5.86	10.79	9.55	16.66	21.01	25.14	14.49	16.00	46.20	40.11	36.01	46.86	30.03	18.06	19.29	26.37	23.39	13.30	11.83	26.79	9.13	19.90	10.37
1916	8.84	8.97	8.24	14.37	24.49	12.46	20.39	29.91	31.93	43.64	68.61	62.23	57.59	43.84	29.76	19.64	14.71	15.56	14.11	12.11	10.54	15.18	9.96
1917	11.53	6.85	8.96	9.73	16.64	33.70	36.97	45.54	44.24	55.61	46.59	34.00	32.84	29.04	22.67	16.10	11.17	8.52	7.44	7.84	5.97	4.53	4.19
1918	8.43	8.23	10.90	25.00	22.01	20.34	13.10	15.26	24.91	45.76	27.67	18.51	12.41	12.67	10.89	8.44	8.46	7.63	8.36	6.10	5.86	5.81	5.91
1919	3.30	3.76	8.23	16.03	10.40	14.40	36.17	33.50	20.93	16.64	21.59	18.97	12.41	10.56	8.96	6.81	5.83	5.92	5.37	4.71	4.44	4.00	2.75
1920	7.52	11.32	9.61	10.18	23.73	30.50	27.77	19.01	26.16	42.16	45.19	30.94	37.36	30.81	27.73	19.89	14.84	11.19	10.07	7.03	6.15	4.45	5.91
1921	8.32	13.04	9.62	8.14	24.39	23.53	51.10	37.27	46.76	40.84	30.94	31.46	25.33	19.61	15.00	12.90	10.81	8.28	7.99	6.73	5.28	4.67	4.38
1922	2.70	7.12	8.96	17.96	13.34	28.94	38.10	36.37	48.49	37.20	33.01	24.39	21.84	25.51	15.56	11.38	9.52	9.47	6.86	5.89	5.51	5.13	4.09
1923	4.13	6.77	6.83	9.07	17.71	20.83	30.97	42.37	52.39	42.67	36.91	30.61	23.87	18.24	16.04	12.59	8.93	6.39	6.61	13.33	7.87	6.07	4.08
1924	5.60	3.84	3.28	7.27	17.97	30.83	22.93	19.06	34.43	44.64	38.34	25.03	26.90	17.09	10.05	7.69	8.60	13.03	11.90	9.98	7.46	4.79	4.54
1925	18.29	19.94	17.69	17.83	18.81	40.93	49.63	36.86	25.26	29.89	37.53	33.36	20.71	11.80	7.64	5.65	6.79	5.64	7.40	6.00	4.92	5.40	4.87
1926	1.67	16.94	11.69	16.81	11.40	7.73	7.51	4.21	5.74	7.37	14.05	12.90	9.74	7.29	2.02	2.05	1.77	3.24	3.38	2.96	4.73	14.80	14.19
1927	4.44	10.24	22.81	21.56	15.11	31.17	66.27	84.69	66.83	73.99	60.86	54.61	38.31	32.13	29.37	22.26	18.53	14.27	18.11	19.00	11.41	11.26	31.87
1928	5.98	5.86	8.14	15.56	25.17	38.79	45.77	37.00	22.56	23.54	45.07	52.96	68.80	35.64	28.54	19.73	17.10	10.84	7.60	6.86	9.19	7.25	5.48
1929	4.52	4.71	7.60	12.20	16.01	27.59	39.97	28.47	44.94	38.93	19.77	15.60	16.50	19.59	12.13	6.58	4.68	3.63	3.94	3.30	3.18	3.79	2.95
1930	12.27	16.34	22.97	29.86	24.87	23.17	33.37	31.57	29.54	26.54	22.17	19.00	12.61	9.60	11.13	10.25	5.95	4.31	4.17	3.32	3.49	3.06	4.30
1931	2.51	2.73	3.61	10.15	15.01	24.97																	
1932																							
1933																							
1934																							
1935																					1.47	1.78	1.94
1936	7.46	8.45	12.06	9.61	23.07	31.70	13.80	18.61	16.03	14.61	8.50	5.76											
1937																							
1938																							
1939																							
1940																							
1941																							
1942																							
1943																							
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1948																							
1949	3.09	4.19	7.25	9.65	11.62	28.87	31.83	33.73	26.46	21.34	16.87	14.73	8.50	8.34	8.13	5.60	3.01	2.40	2.11	2.26	2.36	2.56	3.05
1950	8.29	12.86	8.73	6.88	10.28	28.96	25.64	30.69	40.03	40.99	50.74	37.43	38.57	28.80	21.94	17.63	13.10	10.56	9.38	7.44	6.24	4.85	1.92
1951	9.91	11.14	11.97	47.81	40.40	55.23	44.99	25.57	33.21	44.01	43.04	92.19	53.56	50.84	35.74	23.93	17.07	12.04	10.18	8.26	25.83	21.46	13.74
1952	15.47	19.73	21.61	27.49	17.51	24.56	26.00	20.93	19.43	23.26	17.36	17.40	16.93	12.54	13.76	11.61	8.84	13.13	13.58	6.69	5.59	4.73	3.60
1953	4.13	6.52	24.57	25.74	26.14	17.03	33.50	61.21	174.40	86.50	47.57	34.33	36.06	37.26	28.40	18.60	15.29	12.83	9.72	6.17	3.45	4.87	4.18
1954	9.11	9.49	7.13	9.30	19.76	42.47	54.71	36.04	33.56	35.83	29.61	38.17	37.01	36.44	28.47	20.30	13.73	10.17	8.14	10.29	16.76	10.84	7.09
1955	12.64	5.75	6.03	8.48	9.84	41.57	41.00	27.26	37.09	44.59	36.49	41.37	24.67	34.86	29.59	20.09	12.69	8.37	5.37	4.73	3.65	1.23	2.82
1956	4.16	9.12	12.25	8.44	12.68	22.10	55.54	45.96	42.44	23.20	28.66	19.90	28.30	25.94	22.26	17.10	11.00	6.40	7.84	6.25	5.64	4.53	2.79
1957	3.12	3.79	5.93	26.44	37.17	42.40	39.26	33.73	38.71	26.41	15.90	13.87	9.49	8.87	6.50	4.30	3.14	1.50	1.20	1.01	1.64	0.62	0.67
1958	7.60	7.85	7.10	9.57	31.46	33.26	38.21	27.60	30.11	34.14	27.43	23.87	16.99	16.61	12.37	11.46	10.16	7.29	3.47	2.00	4.56	3.49	2.92
1959	7.29	9.07	9.39	20.89	15.53	26.31	27.46	26.69	48.19	36.91	29.89	13.46	7.85	18.19	17.07	11.44	5.61	4.95	3.78	7.87	5.19	6.77	11.53
1960	12.10	8.30	6.26	10.48	15.43	27.80	15.13	18.80	33.11	22.10	19.54	17.06	15.99	8.57	1.55	0.71	1.15	4.17	2.49	1.40	0.97	0.76	1.55
1961	1.77	0.37	0.84	1.37	2.77	5.35	29.36	44.57	24.11	2.30	2.41	2.13	2.31	2.43	2.50	2.10	1.74	1.98	1.89	1.35	1.42	1.49	1.73
1962	6.71	12.01	16.64	8.50	2.54	6.96	9.74	5.79	1.73	5.08	2.11	1.24	1.32	1.39	1.17	0.84	1.09	0.89	0.69	1.29	1.40	1.50	1.11
1963	0.66	0.49	0.32	1.21	0.82	0.83	1.06	1.04	1.58	1.31	3.48	3.46	9.50	7.44	1.53	0.98	1.30	1.27	1.09	1.19	1.04	0.72	0.92
1964	1.60	0.89	1.11	15.97	17.51	20.64	32.94	23.00	82.44	87.14	47.11	39.61	31.13	25.96	18.83	8.56	1.90	0.81	1.10	0.92	1.04	1.08	0.89
1965	8.37	8.83	13.70	15.93	8.31	15.14	11.64	24.63	28.76	33.90	50.40	37.10	21.34	19.61	12.53	8.05	4.30	2.68	2.30	1.26	1.25	1.70	2.85
1966	10.34	9.51	8.58	9.68	31.34	18.96	16.30	31.61	43.40	28.26	20.14	15.76	16.27	13.63	10.57	8.48	6.62	5.01	3.52	8.44	8.42	4.26	2.00
1967	4.67	4.17	6.08	5.95	31.10	33.84	59.14	52.66	52.57	51.03	54.84	42.49	35.20	21.01	9.87	3.90	1.50	0.96	0.72	1.29	1.52	1.11	2.09
1968	2.13	2.26	1.72	1.65	1.25	0.71	2.19	17.93	28.50	25.10	15.67	7.12	3.62	3.09	1.54	1.79	1.82	1.62	2.36	8.38	8.38	8.54	7.70
1969	10.25	11.66	19.57	13.73	19.91	30.53	22.36	28.84	37.47	22.60	12.72	55.39	24.96	12.83	6.59	5.75	2.73	1.81	1.91	1.68	2.20	1.98	1.14
1970	4.61	3.73	3.55	7.37	23.43	27.43	38.79	32.20	41.23	62.93	57.09	32.93	17.24	10.26	1.47	0.81	2.07	2.08	1.74	0.95	1.00	1.25	2.00
1971	4.65	5.38	12.56	16.49	31.66	28.60	21.09	38.60	36.69	30.70	16.28	5.35	7.21	7.86	7.30	7.02	6.25	6.14	5.15	3.94	3.52	2.58	2.42
1972	9.46	7.45	7.54	11.19	11.57	33.84	43.00	44.01	53.96	44.41	28.64	15.30	7.28	6.75	21.67	31.91	18.36	13.09	8.80	5.92	6.82	3.90	3.60
1973	3.72	4.18	5.27	5.28	5.94	12.32	9.78	3.81	8.36	9.64	4.84	3.10	2.24	1.88	2.03	1.83	1.65	1.28	0.95	0.68	0.47	0.65	0.70
1974	5.08	6.14	14.83	22.46	25.21	14.73	13.74	29.66	33.61	42.61	48.33	26.23	11.43	5.82	5.48	2.91	1.48	1.46	8.22	5.80	4.53	3.78	3.46
1975	2.31	13.51	28.23	11.30	30.49	35.97	25.84	31.57	52.24	43.29	136.74	48.39	34.26	29.49	11.61	3.90	4.10	3.03	3.12	3.29	14.84	18.46	10.41
1976	9.43	11.46	8.18	12.09	34.54	35.26	27.31	23.14	13.09	4.93	9.14	14.52	4.57	6.52	7.89	4.74	3.81	16.41	13.30	9.12	6.82	1.39	1.57
1977	4.84	4.49	3.05	1.86	1.87	3.20	3.01	2.59	2.88	2.66	2.41	2.18	2.00	1.88	1.57	1.79	1.90	2.42	2.14	2.33	2.11	1.84	1.51
1978	2.68	3.01	3.06	10.84	25.29	27.23	27.71	16.86	32.61	22.90	16.64	19.34	23.27	8.98	16.42	9.39	5.70	2.65	2.60	3.58	3.56	3.27	4.06
1979	8.95	7.56	8.24	14.73	20.16	25.06	37.96	30.19	26.77	8.34	3.21	3.26	3.35	2.96	2.54	2.79	2.39	1.93	1.81	2.69	2.23	1.84	1.75
1980	1.96	1.95	4.19	6.11	9.34	2.61	25.27	53.34	28.80	31.84	26.46	6.82	2.04	2.00	2.13	1.77	1.39	1.90	3.35	2.74	2.47	2.25	2.30
1981	2.08	2.25	9.97	10.35	26.13	36.67	80.69	50.99	37.04	46.57	29.00	21.91	18.43	6.39	3.88	5.35	9.58	9.08	4.40	2.35	1.98	1.95	1.91
1982	8.76	5.95	4.15	2.51	3.81	6.29	16.16	21.33	29.11	39.36	38.20	25.01	19.79	17.39	4.40	8.41	13.08	2.50	2.20	2.11	2.63	3.67	5.34
1983	2.35	2.25	3.08	2.98	3.21	13.87	26.20	21.31	6.98	7.55	2.92	2.37	2.07	2.47	5.10	2.74	2.08	1.85	1.58	1.20	1.07	1.03	0.97
1984	1.37	1.36	1.29	1.87	1.78	1.94	1.99	3.04	2.14	2.56	4.02	11.16	8.32	1.85	1.81	1.77	1.91	1.59	1.34	1.00	0.78	0.72	0.78
1985	1.09	1.51	1.41	1.43			19.53	15.81	9.05	5.81	2.64	1.17	0.98	0.89	0.84	0.78	0.69	0.70	0.76	0.89	0.94	0.93	0.97
1986	7.12	5.86	7.02	4.94	7.01	8.09	21.19	46.39	21.96	8.03	3.12	1.12	1.25	1.09	1.02	1.05	1.08	0.88	0.68	0.92	0.93	1.02	1.13
1987	0.81	1.38	1.24	2.50	4.20	4.58	3.03	19.69	10.25	3.56	1.30	1.33	1.24	1.09	2.87	15.96	2.40	2.05	2.19	3.01	6.71	8.93	6.08
1988	1.02	0.92	0.84	0.99	1.37	1.73	1.34	1.71	2.11	1.61	1.59	1.58	1.47	1.24	1.51	1.58	1.62	1.59	1.51	1.60	1.60	1.57	1.59
1989	1.84	1.26	1.26	1.30	3.01	1.19	1.25	1.21	3.42	29.90	9.28	3.56	1.63	1.68	1.50	1.21	1.17	1.23	2.51	2.54	2.34	5.37	11.96
1990	7.51	11.97	19.56	9.65	15.28	9.76	16.54	31.89	18.01	22.51	14.21	15.04	4.00	3.13	1.85	2.91	1.58	1.53	1.70	1.86	2.37	1.92	2.11
1991	8.08	5.63	3.09	1.92	2.08	23.94	43.16	30.39	34.77	21.13	42.04	35.77	30.59	18.34	10.51	2.40	2.21	1.93	4.09	3.82	4.63	3.27	2.31
1992	1.60	1.29	1.34	1.17	1.41	1.25	1.23	1.23	1.19	1.21	1.12	1.12	1.23	1.35	1.10	2.96	1.73	1.67	1.74	1.32	1.30	1.75	1.59
1993	3.45	2.12	1.45	1.74	4.19	12.60	5.23	7.81	8.74	15.45	21.43	8.10	14.59	19.59	15.84	17.57	12.18	6.75	14.80	10.19	7.45	8.05	13.43
1994	4.78	6.28	6.37	4.06	18.36	18.91	24.64	15.12	9.36	7.40	4.59	4.32	3.52	3.11	2.68	2.71	2.61	1.96	1.74	1.86	1.44	1.43	1.43
1995	1.88	1.60	1.48	3.56	12.48	15.79	9.39	24.50	120.44	57.08	44.24	35.59	35.53	25.39	17.21	17.87	13.57	14.61	6.23	1.97	1.76	1.98	1.90

Appendix 2. Actual weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 3 of 6)

UWAT = Waterton River at Waterton Park (Station 05AD003)

Week

Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	7.76	12.80	15.03	15.56	23.36	54.16	60.54	53.97	46.13	59.34	49.47	42.91	36.24	37.81	33.73	32.23	23.41	16.93	11.84	9.25	7.56	7.34	7.93
1913	4.35	15.32	23.47	18.07	17.57	27.47	56.21	142.86	120.86	100.40	65.61	71.69	50.13	33.36	21.14	21.74	19.51	20.99	20.50	16.46	11.90	10.04	8.00
1914	10.23	21.81	31.27	40.14	45.63	63.91	64.97	56.64	66.56	54.16	60.36	39.04	36.93	29.94	22.64	15.06	12.16	10.00	10.78	15.26	13.01	9.47	7.85
1915	9.99	22.24	24.09	34.81	46.33	41.51	32.44	36.51	57.11	48.71	46.50	45.59	37.73	25.84	23.93	22.30	21.34	15.69	12.63	12.00	9.86	13.70	13.17
1916	9.93	15.11	15.06	31.71	49.60	29.07	31.39	34.79	59.67	92.17	168.71	113.89	108.04	90.90	59.34	37.09	25.20	21.67	19.14	17.17	16.01	20.04	19.16
1917	2.99	3.22	4.40	5.03	20.44	70.86	63.54	63.11	84.59	92.07	106.31	76.09	72.57	62.34	43.86	25.89	14.71	11.15	8.67	7.61	7.07	5.74	5.09
1918	10.71	16.47	21.36	23.86	34.90	46.31	30.17	28.43	58.47	113.67	73.84	44.24	24.46	16.41	15.51	13.81	10.81	11.02	9.76	8.67	7.56	7.72	8.82
1919	6.82	8.25	18.23	38.11	24.37	25.87	89.59	63.94	54.74	43.37	50.20	40.00	24.43	16.07	11.63	8.71	7.40	7.17	5.82	4.79	4.60	4.30	3.79
1920	3.24	4.39	6.32	10.27	21.53	42.36	56.69	37.30	48.90	91.76	112.61	75.60	87.40	58.94	40.17	26.66	17.16	12.77	12.06	8.48	7.28	6.00	5.99
1921	12.14	20.59	19.49	16.03	41.31	52.01	112.41	101.10	115.89	108.64	77.09	73.50	54.57	39.16	26.13	19.60	14.81	11.33	9.94	9.00	7.22	6.11	6.15
1922	2.98	3.08	8.00	25.97	23.79	59.01	66.61	86.50	119.76	95.73	80.40	49.64	35.39	33.87	20.47	14.64	11.37	9.89	7.46	5.86	5.51	5.43	4.84
1923	4.42	11.75	15.67	18.60	35.99	50.19	73.06	112.06	114.14	97.81	65.30	56.91	37.77	26.93	20.61	15.61	12.26	9.93	7.91	12.47	10.88	8.22	7.04
1924	4.81	5.54	6.82	14.58	38.91	89.93	74.50	54.86	73.51	111.36	84.10	51.83	46.29	27.33	17.73	14.71	11.00	13.37	12.29	11.60	9.12	7.55	5.91
1925	20.46	30.26	21.86	24.03	39.80	69.90	100.63	78.24	55.13	70.49	82.57	71.80	41.04	25.13	18.26	13.83	11.99	9.84	9.74	10.39	9.76	8.56	8.68
1926	10.34	33.44	32.33	42.86	31.79	26.13	25.11	20.09	18.47	17.90	20.07	20.09	17.31	12.96	10.90	9.42	7.76	7.03	5.35	4.75	6.57	16.13	18.73
1927	3.44	5.91	20.27	39.47	24.77	60.37	67.79	78.23	116.86	140.71	124.71	111.47	75.29	66.29	61.84	35.26	22.19	18.26	19.30	16.87	14.83	15.11	25.91
1928	6.89	5.63	9.09	25.91	56.63	91.87	119.71	92.80	43.44	60.40	85.71	89.44	91.69	74.70	42.86	21.67	19.17	13.00	9.65	8.76	10.30	9.80	8.55
1929	4.18	4.34	7.31	19.91	23.40	48.06	93.90	73.70	86.69	80.50	44.37	34.70	29.47	28.30	19.57	14.23	9.26	9.00	8.15	5.72	4.69	4.31	4.12
1930	21.24	31.80	45.56	60.69	49.93	42.23	66.24	60.39	68.39	61.19	47.17	36.93	31.51	26.29	21.69	15.69	11.24	8.59	7.28	5.62	4.52	4.45	5.04
1931	4.03	4.98	8.12	29.57	42.29	61.59	46.53	56.10															
1932																					8.27	6.77	5.38
1933								99.10	99.10	117.19	108.73	80.59	65.13	50.80	35.00	21.87	15.27	12.50	10.99	10.39	9.91		
1934																							
1935																							
1936																							
1937																							
1938																							
1939																							
1940																							
1941																							
1942																							
1943																							
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1946																							
1947																							
1948	2.89	8.61	19.51	21.24	25.43	31.89	132.24	140.14	134.14	113.64	123.74	66.14	38.06	21.63	16.40	15.74	23.26	16.67	12.16	9.20	6.89	5.58	4.59
1949	4.77	11.19	19.80	25.54	39.33	82.39	66.44	80.30	71.99	54.67	32.31	30.57	21.66	19.77	17.31	14.14	13.57	9.94	6.53	5.60	4.93	4.97	5.09
1950	4.21	8.65	11.59	9.97	14.42	54.93	53.36	67.56	65.51	101.86	128.43	97.91	98.94	65.79	41.54	31.81	23.37	16.66	12.83	10.22	8.27	6.95	5.83
1951	12.53	16.80	18.54	40.17	74.29	64.54	95.09	54.33	39.09	87.13	84.70	92.47	89.16	73.39	62.41	39.00	27.27	18.60	13.50	10.87	22.66	31.04	21.07
1952	6.78	19.33	37.10	54.34	35.80	55.99	67.24	56.17	55.14	50.83	37.59	34.39	34.19	26.43	21.63	17.87	13.53	15.57	15.81	10.40	7.44	6.30	5.65
1953	5.28	5.96	20.44	27.94	46.97	41.21	62.79	99.06	160.14	136.66	82.54	57.44	65.69	67.74	47.94	27.27	18.46	15.23	11.73	9.07	7.44	7.24	6.21
1954	5.20	9.04	9.96	8.48	24.34	79.87	120.16	75.69	69.87	77.14	69.57	91.70	94.60	84.01	62.14	35.44	23.49	17.91	14.09	13.59	22.30	17.50	11.91
1955	3.57	4.91	5.15	6.17	11.69	26.94	47.63	44.71	76.16	111.40	94.90	92.94	48.73	59.23	51.36	31.37	19.63	14.03	9.84	7.57	6.18	5.06	4.89
1956	4.57	14.76	24.09	16.20	16.80	38.01	123.64	115.14	99.59	73.03	70.66	52.39	49.24	45.69	36.26	26.04	18.19	12.94	10.81	8.96	7.93	6.59	5.69
1957	2.68	2.74	7.66	51.31	89.01	98.20	90.93	82.73	93.63	67.30	44.09	33.86	25.19	19.03	14.97	11.02	8.61	6.92	5.63	4.64	4.09	3.29	2.92
1958	6.00	11.50	12.13	17.26	66.06	80.36	100.26	84.54	72.90	69.61	49.26	35.91	24.56	21.56	17.16	15.27	12.10	8.42	6.91	5.86	5.27	4.05	3.78
1959	11.74	15.67	17.84	32.16	29.80	45.26	54.44	54.81	116.04	90.30	100.57	75.59	54.56	42.67	38.60	28.61	17.89	11.68	8.67	8.31	8.98	12.06	21.29
1960	20.80	17.70	13.17	12.09	24.67	61.16	30.51	42.31	92.84	75.90	63.50	51.06	48.26	35.80	26.89	18.86	14.47	13.90	9.75	6.74	5.43	5.27	5.41
1961	8.12	7.90	8.98	11.70	19.29	32.00	95.93	123.86	122.57	84.83	79.63	46.64	27.21	21.67	17.37	14.17	10.73	8.44	6.85	5.84	5.12	5.18	5.25
1962	8.37	20.67	38.16	25.60	20.81	36.84	60.89	65.00	49.54	68.51	68.77	49.56	30.51	22.27	17.17	14.04	12.79	10.23	8.01	6.47	5.81	5.60	6.25
1963	5.98	9.12	10.04	19.76	28.63	32.87	56.16	75.34	87.56	105.21	71.33	57.10	64.20	40.24	23.31	15.79	11.30	9.05	8.44	6.84	5.39	4.40	4.26
1964	3.93	4.76	6.53	18.53	31.03	44.87	72.61	57.20	220.10	191.29	88.09	84.39	62.80	51.23	34.84	21.71	15.79	11.41	9.18	7.27	6.29	7.19	8.07
1965	4.84	8.63	18.54	34.86	28.87	55.87	43.34	73.24	86.29	103.71	124.10	76.59	59.47	54.53	35.97	23.79	18.99	15.87	12.41	10.15	8.52	7.87	9.00
1966	17.46	16.79	12.79	16.56	61.53	42.30	44.21	103.94	92.01	77.19	63.03	48.01	45.34	35.57	25.23	17.51	12.64	10.30	8.30	11.37	11.09	8.92	7.42
1967	4.29	5.53	6.33	7.64	14.28	32.39	107.01	95.76	95.50	96.06	112.87	95.17	79.96	52.50	35.44	23.24	17.37	13.29	10.32	8.60	6.66	5.32	4.79
1968	6.32	6.28	6.23	12.11	22.76	29.94	66.09	73.01	89.20	81.44	63.53	54.21	41.14	39.07	25.10	18.77	14.90	11.83	11.14	12.49	11.21	10.35	9.22
1969	13.89	20.53	31.89	27.10	40.07	68.33	57.73	75.61	96.76	60.36	44.01	83.66	53.86	32.27	21.41	15.91	11.93	8.35	6.39	5.20	4.57	3.98	3.58
1970	3.09	3.75	4.28	7.38	37.50	53.40	90.39	81.91	117.64	131.23	108.66	65.57	36.07	26.74	19.17	14.00	11.04	8.99	6.66	5.28	4.54	4.33	4.59
1971	4.09	6.91	24.33	38.57	75.76	71.14	54.69	105.91	93.34	78.69	64.49	73.26	54.37	46.04	45.96	37.31	25.46	20.69	13.91	8.79	7.26	6.73	5.46
1972	14.21	11.74	9.99	17.29	21.99	67.01	92.63	107.39	137.57	112.70	74.37	58.73	55.61	52.31	49.71	46.44	35.76	25.63	19.20	16.56	14.64	11.14	11.37
1973	4.46	6.55	8.38	10.92	19.07	60.51	71.74	47.86	65.69	64.74	40.70	44.47	27.21	19.00	14.20	10.95	8.73	7.95	6.64	5.36	4.68	4.65	4.31
1974	5.96	8.82	23.04	36.63	54.89	32.09	30.33	66.20	79.50	119.00	158.00	115.63	73.07	55.03	50.10	36.67	25.27	19.07	15.66	11.43	9.67	7.98	7.56
1975	2.15	2.37	3.82	6.01	26.91	66.44	46.46	56.16	112.66	98.63	250.29	100.31	100.04	94.87	45.66	26.43	24.06	16.00	11.46	11.53	15.21	13.57	9.99
1976	11.04	19.99	14.40	18.27	67.49	80.01	62.13	60.87	38.63	51.81	58.73	50.80	55.06	53.69	30.24	27.63	20.36	22.13	24.07	19.24	14.93	10.64	8.33
1977	6.32	7.88	14.63	34.79	33.97	34.47	26.01	25.93	41.01	33.60	24.21	17.30	11.43	8.62	7.76	7.97	8.14	7.51	9.94	10.43	10.68	13.36	12.30
1978	9.43	9.15	10.25	31.61	36.57	55.06	65.89	45.64	95.14	74.47	56.91	62.34	55.96	37.34	34.79	25.29	17.01	11.31	9.39	12.09	12.66	10.59	14.70
1979	4.85	5.53	7.05	19.64	26.06	41.24	77.87	74.34	75.97	61.99	47.89	38.44	29.66	22.00	15.09	11.76	8.38	6.56	5.53	6.24	6.04	5.07	4.49
1980	3.01	8.33	39.96	71.03	59.36	42.81	80.07	102.37	54.46	70.97	62.31	30.29	19.41	15.00	12.70	10.66	8.38	7.13	7.17	8.66	7.74	7.30	7.35
1981	5.59	6.82	25.96	53.60	37.09	49.86	129.93	95.94	68.91	52.47	52.64	52.61	51.23	33.63	26.39	24.50	17.40	11.99	9.64	7.45	6.05	5.24	4.21
1982	3.44	4.21	6.72	12.56	15.11	32.06	64.79	54.67	65.33	94.83	105.29	91.37	65.40	40.06	31.13	22.84	17.99	13.67	10.84	8.70	7.17	5.88	5.13
1983	3.87	4.80	16.36	16.63	19.86	20.21	51.96	86.99	62.64	57.46	39.40	34.70	30.09	29.23	32.90	21.74	15.04	12.23	9.72	7.22	5.90	5.10	4.25
1984	3.44	9.74	20.50	14.80	12.54	26.63	44.31	52.63	50.90	46.71	63.79	61.37	40.96	26.77	19.74	14.46	12.84	10.21	7.84	6.18	4.40	3.83	4.60
1985	8.21	21.96	18.39	40.89	38.46	37.41	84.94	68.11	64.63	56.47	43.23	26.83	22.49	17.90	12.46	9.04	7.07	6.43	11.55	12.34	9.02	8.04	16.78
1986	14.77	14.46	28.34	23.83	27.71	25.81	57.99	123.29	84.69	53.84	35.69	25.49	20.39	15.21	11.84	10.02	7.72	6.69	5.59	4.42	4.13	4.39	5.66
1987	11.70	19.53	27.41	68.64	72.11	63.07	36.23	56.69	40.26	36.23	27.74	18.36	14.83	12.23	20.84	39.74	20.11	12.46	12.56	12.50	12.59	9.66	7.53
1988	9.46	20.29	23.96	20.67	27.04	56.74	48.43	51.89	52.86	43.00	33.31	25.50	18.37	13.26	9.68	7.36	6.36	5.56	4.78	3.99	3.50	2.95	2.59
1989	5.99	15.03	29.84	28.44	70.31	48.73	33.07	33.17	80.63	95.61	53.00	40.39	31.40	25.24	23.83	17.36	12.49	9.18	7.94	9.24	20.27	20.17	18.27
1990	12.63	17.20	35.16	28.10	42.29	31.07	42.86	74.50	52.33	58.81	69.73	84.53	58.54	40.44	30.67	28.51	23.89	15.09	10.94	9.75	7.27	5.81	4.82
1991	14.17	12.31	22.61	21.11	24.94	85.21	111.64	74.63	88.93	83.04	101.61	94.60	83.86	54.33	40.44	28.53	22.46	17.41	13.79	10.45	7.94	6.45	5.71
1992	7.70	9.43	13.33	31.59	44.16	28.27	29.76	34.84	32.56	31.33	32.80	24.40	26.39	21.61	17.06	13.23	10.34	8.24	6.83	6.14	7.15	6.66	5.79
1993	6.78	7.65	9.25	11.38	23.23	79.90	69.14	54.00	40.91	36.17	47.24	30.07	28.33	38.46	36.41	30.24	25.26	15.90	12.64	12.53	11.81	12.17	11.34
1994	6.58	13.26	29.64	20.59	46.96	60.00	52.77	55.97	44.90	37.41	29.59	30.26	23.09	15.96	12.10	9.79	7.88	6.52	5.36	4.44	3.68	3.19	2.66
1995	6.78	6.91	8.32	10.96	33.77	58.10	57.27	89.83	217.57	98.90	87.79	76.46	61.60	50.31	34.74	29.57	20.77	15.99	13.13	10.67	8.59	7.18	6.14

Appendix 2. Actual weekly flows (cms) during the cottonwood growing season
(weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 4 of 6)

LWAT = Waterton River at Standoff & Glenwood (Stations 05AD008 & 05AD028)

Year \ Week	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912																							
1913																							
1914																							
1915																							
1916	20.60	22.16	21.76	35.13	58.34	36.04	46.03	66.00	88.21	112.86	216.29	148.71	128.43	109.43	75.89	42.81	26.19	23.80	21.67	21.90	18.70	24.83	23.00
1917	16.51	10.48	11.82	16.91	38.43	86.34	94.99	111.96	95.64	118.57	130.14	96.04	86.44	65.96	44.39	28.91	18.91	15.03	11.64	10.17	9.00	7.69	6.56
1918						56.27	35.69	33.99	58.39	113.47	76.76	48.99	26.01	21.24	17.61	16.67	13.39	12.29	12.96	11.03	9.43	13.80	16.91
1919	6.98	7.71	13.81	39.23	27.29	30.73	94.53	96.23	54.96	41.44	48.50	43.47	44.34	23.37	9.47	8.87	10.67	10.23	9.66	6.99	5.59	5.52	5.36
1920	10.34	15.09	19.54	22.81	51.14	69.19	66.89	48.66	60.63	100.69	118.00	81.71	86.64	64.80	47.56	30.93	19.24	13.80	14.19	12.29	9.17	7.16	6.90
1921	17.21	29.34	26.07	23.30	58.33	61.20	115.14	110.29	123.86	110.56	86.90	79.67	65.77	47.00	30.33	23.30	19.67	14.71	12.17	9.42	7.72	6.86	7.64
1922	6.52	19.37	16.67	43.54	36.71	73.64	107.86	110.66	148.71	103.86	88.09	60.07	41.30	45.63	27.73	17.27	13.91	11.30	10.66	9.32	7.70	6.99	6.57
1923	8.40	15.50	19.29	25.86	46.26	63.17	80.26	203.56	192.86	135.91	113.67	93.24	54.33	37.54	30.41	22.86	17.19	14.04	11.69	28.36	18.80	12.69	10.91
1924	13.00	9.58	11.09	21.81	46.53	88.03	78.59	61.20	104.73	140.86	113.21	63.63	54.21	39.19	29.37	21.73	17.71	26.69	23.19	18.99	13.14	9.75	7.90
1925	36.79	51.10	44.87	38.91	50.44	102.69	143.00	105.63	74.47	94.61	104.96	78.79	55.69	35.39	26.03	20.93	15.67	12.41	12.30	13.73	11.34	10.68	10.27
1926	11.98	39.39	42.34	50.01	40.69	33.16	30.07	23.49	20.97	20.27	39.37	40.17	26.36	15.63	12.81	10.42	7.77	7.18	7.18	5.91	6.57	22.06	36.10
1927	12.24	23.20	44.06	59.20	43.64	79.76	141.29	193.14	191.43	196.86	148.57	134.57	103.91	91.03	88.63	53.69	35.34	23.73	27.44	32.70	19.83	18.57	83.17
1928	15.71	15.21	21.87	33.49	62.39	109.81	157.57	108.61	57.57	69.89	150.73	152.57	171.29	70.50	51.00	35.80	26.71	20.10	14.64	12.30	27.19	16.69	13.31
1929	8.95	11.56	21.96	31.84	46.77	66.73	115.20	96.50	121.57	100.59	60.30	42.34	41.83	37.44	25.41	17.80	13.43	11.20	8.95	6.27	5.47	6.25	6.16
1930	27.57	39.11	52.19	70.56	65.37	57.64	79.36	79.34	80.94	73.79	60.91	49.67	34.73	27.90	25.06	20.29	14.81	10.93	9.97	8.66	6.80	5.95	8.46
1931	5.51	6.32	7.87	29.00	42.76																		
1932																							
1933																							
1934																							
1935	9.05	15.44	13.97	21.23	27.71	33.37	81.96	78.69	75.29	74.27	65.17	53.00	39.69	34.01	31.37	25.03	18.51	12.77	9.53	7.77	6.92	7.14	6.70
1936	20.31	13.21	31.36	32.27	60.64	108.26	66.47	85.36	89.29	54.94	36.97	27.89					6.70	6.10	5.70	6.72	5.41	5.76	5.58
1937	6.75	7.96	9.56	21.36	38.10	53.33	64.43	94.97	89.50	231.23	121.61	59.27	39.69	26.13	20.53	15.07	13.51	10.60	8.96	8.63	6.25	6.71	5.36
1938	12.01	23.00	31.91	48.73	44.64	68.46	119.99	136.29	113.57	91.36	95.79	84.93	57.76	36.13	24.31	18.87	14.71	12.01	10.54	6.92	7.62	7.23	7.18
1939	8.28	8.57	32.09	55.71	54.20	60.20	54.09	52.76	40.81	46.71	51.86	41.27	31.23	21.90	15.86	10.47	8.41	7.87	6.12	4.77	4.15	4.25	4.48
1940	6.70	10.30	23.74	28.67	38.10	60.94	58.77	63.10	52.83	48.43	41.67	31.51	23.13	16.60	12.61	13.00	19.40	10.76	7.14	6.23	5.18	5.76	5.56
1941	7.59	11.89	17.87	38.83	34.87	42.63	48.14	52.36	48.51	38.09	33.00	34.90	32.66	25.39	18.69	14.50	10.81	8.14	7.26	6.65	7.88	7.56	10.55
1942	13.74	23.79	42.27	31.61	54.59	77.06	100.37	88.79	216.74	90.11	63.79	120.94	91.56	55.70	37.81	32.09	36.60	27.80	20.63	15.19	14.50	15.11	12.81
1943	31.81	58.30	55.13	48.03	44.17	47.29	80.23	124.71	80.71	95.29	120.16	92.24	92.67	75.21	50.84	41.84	31.61	20.73	13.90	9.96	9.02	8.81	7.96
1944	5.79	5.33	5.25	9.48	17.43	44.21	56.24	47.46	49.64	46.53	56.76	48.17	35.90	22.69	14.01	9.90	8.11	6.64	10.24	10.24	8.57	7.57	5.97
1945	4.44	5.69	7.14	19.31	61.57	67.81	66.23	126.14	157.14	100.64	104.30	96.83	52.34	36.33	24.69	16.23	11.97	10.01	8.32	6.51	5.63	4.89	7.58
1946	8.36	16.60	31.67	45.00	56.30	68.99	91.09	108.61	103.84	85.96	74.84	57.36	41.86	38.37	26.71	18.20	13.76	10.25	8.16	6.78	7.87	11.49	13.33
1947	17.11	23.66	39.80	77.50	106.37	81.04	61.51	76.23	85.13	94.83	70.10	63.14	52.44	41.97	29.43	21.00	14.54	10.73	9.54	12.17	14.59	10.29	8.03
1948	4.95	47.77	35.47	35.66	48.17	84.74	183.86	189.14	173.29	246.86	238.00	114.10	63.99	36.73	30.67	26.29	44.86	30.54	20.49	14.36	11.97	9.82	7.88
1949	10.59	12.66	17.91	23.50	30.86	99.89	104.13	110.00	89.09	72.23	45.86	36.16	26.87	31.94	34.71	26.19	22.43	19.37	15.41	12.67	11.07	10.09	10.15
1950	21.87	29.29	28.01	24.59	34.47	81.26	71.81	83.46	99.03	130.10	164.57	116.86	114.20	80.00	51.09	40.31	31.90	24.36	19.84	15.70	11.69	9.72	8.50
1951	29.60	33.04	38.90	91.71	109.60	140.43	130.86	86.53	94.06	131.29	126.50	182.14	150.43	138.00	107.67	75.40	58.59	50.79	44.04	39.10	86.44	87.13	62.33
1952	27.44	42.94	51.17	68.73	50.66	77.71	95.04	72.14	69.74	72.77	49.24	46.49	43.00	37.77	40.33	32.30	20.00	29.03	33.01	17.36	13.60	11.34	9.67
1953	7.70	12.37	50.34	60.86	76.53	62.99	87.54	156.29	273.57	157.86	100.31	73.53	72.14	76.81	61.47	41.94	29.97	23.71	17.93	13.04	10.37	9.86	8.31
1954	14.58	21.14	16.03	16.90	50.29	111.24	160.43	105.60	98.23	91.60	106.29	110.86	128.00	106.99	80.79	49.70	29.64	21.94	16.74	16.54	28.21	22.37	14.93
1955	20.92	10.90	12.14	12.36	21.39	82.19	97.03	68.21	96.86	139.00	122.57	115.29	63.63	74.73	64.57	41.17	26.56	18.70	13.44	8.43	8.39	6.93	5.01
1956	16.73	20.04	35.87	24.99	35.33	66.56	165.43	148.00	128.27	96.26	92.79	66.69	82.24	64.16	48.73	30.37	25.03	17.80	12.93	11.37	10.46	7.08	7.08
1957	5.96	7.60	13.39	53.01	99.20	130.71	132.14	99.81	115.71	92.96	60.83	37.29	28.71	21.46	17.83	13.43	11.34	10.15	7.94	6.72	6.38	6.23	6.35
1958	25.47	21.16	17.61	24.91	87.16	128.71	128.29	111.64	107.27	105.76	75.97	54.90	38.04	34.89	24.31	21.41	16.10	11.09	9.65	8.89	7.73	7.18	7.15
1959	17.67	28.03	29.01	52.29	47.04	75.01	96.67	76.30	145.43	110.76	119.71	105.94	73.33	50.96	49.04	37.26	23.09	14.53	12.17	11.19	10.94	10.81	21.66
1960	27.50	24.13	18.83	24.21	47.94	83.06	46.36	55.81	103.79	85.29	89.24	53.07	56.31	42.96	30.81	23.24	19.37	21.87	12.61	8.49	6.91	6.10	5.66
1961	9.36	10.06	12.20	17.11	31.29	62.89	147.44	174.00	167.14	127.86	103.97	61.89	37.41	28.01	20.77	17.24	13.77	9.63	8.01	6.49	5.88	6.02	6.08
1962	15.80	27.04	52.09	31.84	26.16	45.76	74.50	77.23	57.20	95.36	77.06	59.69	38.87	28.33	22.77	16.94	15.86	12.90	10.20	8.81	6.86	7.95	7.81
1963	5.39	11.92	9.41	21.99	35.97	41.81	65.77	85.24	96.64	130.14	91.34	82.24	88.41	48.17	28.60	18.67	13.47	11.24	9.79	7.68	8.02	5.62	5.53
1964	7.08	6.80	7.05	58.52	59.74	62.31	100.23	80.10	205.86	317.29	127.00	111.13	87.46	77.77	46.39	25.47	16.93	12.17	9.64	7.68	7.67	8.92	10.05
1965	15.50	16.51	17.07	18.31	10.59	6.47	24.93	54.93	102.26	117.40	181.29	148.90	80.94	77.79	54.43	41.91	26.43	24.11	16.39	13.29	11.09	10.51	11.54
1966	6.27	14.84	19.09	21.71	72.73	59.83	53.13	123.97	152.86	112.66	83.66	70.39	65.81	55.64	42.76	29.64	19.31	15.71	10.40	16.97	16.97	13.16	10.31
1967	9.51	10.56	12.57	15.39	59.36	89.79	156.71	135.57	157.71	157.71	153.29	125.86	105.73	68.29	44.81	28.67	20.41	16.37	5.91	4.75	4.67	4.64	4.62
1968	7.72	9.62	9.95	9.71	20.74	33.49	78.93	92.23	114.57	110.37	76.09	52.46	35.29	32.01	34.94	20.44	18.74	17.87	16.50	16.27	15.94	16.09	15.71
1969	11.24	9.81	10.11	38.43	51.66	127.43	91.36	101.74	134.61	90.04	45.00	171.04	78.84	24.69	19.19	8.00	5.86	4.76	6.56	6.97	6.41	4.80	2.83
1970	9.62	7.44	7.82	14.60	48.73	67.69	110.87	95.07	74.44	157.69	137.61	82.89	34.43	19.43	5.83	5.83	5.29	5.72	5.06	5.94	5.84	5.63	5.95
1971	8.06	11.44	26.06	40.97	96.53	93.60	70.34	138.43	115.57	99.39	51.30	57.04	36.16	28.40	40.41	22.76	20.50	10.98	7.38	6.52	5.77	5.19	3.86
1972	24.21	20.30	19.83	28.13	34.59	82.90	127.43	132.43	180.29	153.63	88.49	58.14	40.00	20.10	30.51	56.06	45.66	38.71	26.04	14.53	14.43	13.83	12.40
1973	7.87	6.58	9.92	14.51	12.59	25.36	42.14	19.00	22.51	49.56	31.54	34.90	20.61	11.28	4.80	3.37	2.93	2.74	2.19	1.69	2.81	3.37	3.30
1974	10.05	13.06	30.70	56.19	66.01	49.34	45.09	80.96	96.51	126.51	176.14	113.84	51.99	48.80	49.81	41.73	21.19	9.78	24.27	21.09	14.03	11.18	6.81
1975	3.17	9.58	33.40	26.59	74.10	109.20	84.80	82.97	150.14	119.43	374.00	136.43	101.19	109.83	46.80	15.17	19.46	10.23	4.15	2.17	1.59	1.35	1.46
1976	14.59	29.16	26.24	28.31	71.54	103.11	75.70	73.23	41.63	32.56	43.54	54.51	26.77	41.11	40.89	35.51	20.07	31.57	40.01	26.01	10.73	10.47	12.20
1977	1.53	1.45	2.24	7.75	5.35	2.74	2.68	2.73	2.89	3.16	2.86	2.58	2.29	2.15	1.94	1.66	1.69	1.82	1.94	1.79	1.56	1.47	1.49
1978	1.91	2.36	2.53	19.50	38.69	58.47	85.06	63.60	89.60	100.43	59.99	61.51	64.09	40.64	32.59	41.64	22.14	17.80	11.81	9.04	17.20	23.20	22.69
1979	15.59	15.44	15.31	30.69	44.70	53.40	85.91	101.80	85.04	64.90	28.77	5.69	1.77	1.70	1.69	1.93	1.95	1.87	1.93	2.30	1.83	1.70	1.74
1980	1.55	1.71	1.33	9.49	30.34	1.29	69.89	128.54	82.13	73.91	76.60	31.76	10.53	1.89	1.87	1.84	2.11	2.44	2.08	2.00	1.97	1.84	2.34
1981	2.34	2.39	2.10	7.75	43.37	81.96	188.00	105.89	66.47	73.56	52.71	38.36	38.13	23.60	2.78	2.89	2.24	2.16	2.28	2.32	2.19	3.51	1.86
1982	3.90	2.81	2.82	2.51	2.53	2.44	7.63	58.20	66.74	79.16	105.04	78.71	56.29	9.34	19.07	8.18	4.42	2.63	2.38	2.08	1.87	1.80	1.96
1983	2.04	1.91	2.18	2.03	1.98	2.12	26.80	79.31	22.64	6.68	2.21	2.27	2.31	2.22	2.40	2.68	2.66	2.44	2.18	2.47	2.17	2.04	1.95
1984	1.63	1.74	1.68	1.63	1.64	1.72	1.72	1.71	1.64	1.96	4.82	26.89	11.01	1.74	1.72	2.14	2.64	2.35	2.31	2.26	2.31	2.17	1.73
1985	2.04	1.89	1.76	1.66	10.51	21.14	55.09	69.53	41.81	15.48	8.83	1.97	1.68	1.68	2.56	3.10	2.92	2.57	2.10	1.43	1.22	1.63	2.07
1986	16.12	14.38	26.36	18.89	20.50	26.07	53.94	113.49	92.46	25.84	4.10	2.36	2.22	2.06	2.00	1.70	1.32	1.34	1.35	1.65	1.96	2.24	1.93
1987	16.87	23.04	32.91	67.96	17.93	22.46	2.03	8.31	4.93	3.54	1.73	1.64	1.59	1.54	3.77	24.75	3.27	3.50	3.67	3.44	5.75	15.93	23.70
1988	1.16	1.14	1.10	1.05	1.18	1.04	1.10	2.05	2.17	2.08	1.92	2.11	1.99	2.05	2.17	2.55	2.71	2.03	1.95	1.87	1.79	1.75	1.88
1989	3.10	1.29	1.28	1.18	0.98	0.91	0.97	1.37	8.18	71.06	14.47	1.13	0.98	1.17	1.21	2.24	2.17	2.13	1.96	1.91	2.16	4.50	5.92
1990	17.33	23.04	45.61	45.63	52.80	43.36	43.43	102.99	65.40	50.07	42.13	35.97	6.38	2.26	2.26	3.41	3.61	3.50	3.61	3.73	3.57	3.57	3.59
1991	13.36	8.08	3.31	10.78	3.05	34.95	96.09	39.73	47.83	40.16	103.49	83.26	78.49	45.46	25.87	3.83	4.27	4.31	12.04	12.77	5.61	3.01	2.46
1992	2.21	2.80	2.89	2.92	2.97	2.99	3.05	3.08	3.14	3.66	3.23	3.29	4.26	4.56	2.90	3.22	2.70	2.45	2.89	3.58	3.57	3.56	3.17
1993	5.35	4.70	4.47	3.71	3.38	30.53	56.14	12.52	20.14	37.79	53.76	14.92	20.58	33.47	40.61	66.14	34.71	25.06	24.89	20.13	11.28	17.44	26.41
1994	7.83	4.73	4.97	5.48	22.36	30.99	59.17	41.54	23.03	29.60	15.55	4.59	4.29	4.08	3.58	4.34	4.39	4.53	4.26	4.17	3.95	3.79	3.38
1995	3.11	3.16	3.34	4.13	25.44	72.89	69.77	82.11	345.57	127.86	107.14	103.46	80.99	56.16	28.64	38.56	20.17	12.70	8.56	6.88	5.27	5.37	6.60

Appendix 2. Actual weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 5 of 6)

USTM = St. Mary River at US / Canada Border (Station 05AE27)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	13.34	17.13	19.90	22.17	29.83	64.17	87.81	75.60	57.99	75.54	65.20	67.20	52.54	45.13	40.11	45.53	34.70	31.43	23.77	21.64	17.06	15.27	16.67
1913	13.76	32.27	31.34	27.91	28.29	39.87	68.86	144.00	144.43	136.71	109.83	107.20	83.51	63.00	40.37	41.13	37.34	41.30	35.80	25.54	23.53	20.76	16.30
1914	11.90	21.43	30.26	45.31	52.59	72.11	76.59	69.09	74.79	61.69	67.56	50.10	52.26	49.84	37.41	26.34	23.36	20.43	18.83	21.47	17.66	14.49	12.66
1915	10.00	21.00	25.30	43.04	53.39	53.13	37.93	44.14	68.11	60.76	62.69	70.63	63.43	47.30	44.13	39.04	37.24	29.80	27.07	24.91	20.29	33.23	22.21
1916	18.00	19.27	19.51	30.60	56.89	43.83	48.69	56.91	61.17	107.36	217.43	160.71	151.71	113.57	90.73	58.64	42.87	39.20	35.97	30.77	28.80	40.37	31.67
1917	16.84	11.31	13.41	14.37	33.47	85.77	84.57	102.44	99.03	134.86	131.43	104.67	85.94	75.03	56.97	38.37	22.40	15.41	12.49	12.74	9.72	6.90	11.60
1918	17.37	23.09	25.41	42.81	78.43	58.96	41.71	34.84	57.41	129.00	89.64	52.80	28.57	23.09	21.20	17.43	13.86	15.71	15.74	13.36	12.96	13.11	14.17
1919	7.04	5.69	7.44	29.56	21.13	18.24	68.03	100.96	41.66	28.84	32.60	36.09	23.73	16.86	16.13	15.61	13.56	12.39	10.91	10.12	9.31	8.42	7.61
1920	10.37	20.03	12.49	14.81	36.76	56.23	73.19	42.71	48.74	105.43	113.14	66.63	59.00	43.61	53.66	53.40	37.17	18.76	19.80	11.72	14.70	12.77	12.23
1921	15.49	23.86	22.56	23.00	51.01	61.83	122.29	107.30	114.29	112.16	74.11	59.67	46.31	37.29	32.99	27.20	21.84	16.10	20.74	18.81	15.39	14.09	12.77
1922	4.45	5.69	13.44	31.07	32.49	49.30	88.11	106.40	136.71	117.86	94.23	47.93	35.36	32.69	23.06	28.53	18.93	13.93	16.21	20.67	13.31	12.31	10.71
1923	8.86	13.54	17.77	29.16	49.96	61.76	74.36	88.43	91.71	77.43	55.67	47.73	40.79	25.74	32.43	24.44	17.93	13.83	14.24	24.00	23.03	29.93	32.73
1924	13.43	9.39	9.64	14.67	32.61	65.26	55.54	41.66	59.56	74.31	78.09	56.84	62.06	52.70	36.97	30.03	18.60	17.79	16.54	13.83	12.27	10.84	11.67
1925	25.21	40.27	36.81	30.76	48.89	67.96	121.90	109.71	71.57	71.90	94.89	92.93	62.06	32.94	26.31	22.73	21.16	17.54	17.73	22.81	19.81	18.21	9.21
1926	5.16	16.30	23.49	28.67	22.01	18.60	21.99	17.11	18.61	17.94	22.00	21.94	19.74	17.36	15.06	11.77	10.84	9.02	7.95	7.53	9.05	17.16	18.44
1927	4.84	14.52	25.68	58.50	37.57	67.79	117.43	124.14	133.50	169.29	154.29	116.81	91.41	75.73	57.47	45.39	34.10	26.54	28.06	31.47	30.53	36.44	52.01
1928	10.83	13.57	22.17	33.84	69.91	116.14	135.71	129.76	63.51	41.66	57.37	83.87	102.83	66.74	56.39	42.39	35.33	23.57	18.29	14.16	18.51	15.16	13.73
1929	7.82	8.29	10.91	18.20	27.14	35.10	77.84	68.81	75.67	81.67	49.23	28.26	30.14	29.24	19.91	15.91	13.09	12.71	11.03	8.96	8.94	9.04	6.14
1930	25.91	40.53	55.00	69.94	58.30	45.40	60.93	65.71	74.19	75.67	44.47	37.96	31.41	25.09	20.99	16.56	13.84	12.36	12.23	9.64	7.50	6.28	11.70
1931	4.35	4.64	4.38	18.34	30.34	54.09	40.14	42.03	37.53	32.50	27.13	21.23	17.56	16.04	16.03	14.66	23.27	16.16	10.28	8.88	7.71	12.24	11.03
1932	8.98	9.15	16.90	15.06	31.86	56.26	68.43	42.39	55.86	56.27	77.31	62.01	43.77	26.59	21.84	18.43	16.31	14.10	10.62	11.96	10.01	7.74	13.14
1933	8.51	10.01	15.21	24.87	38.51	42.69	47.04	83.57	113.57	98.47	86.43	61.70	53.89	48.67	37.59	22.93	19.36	16.77	15.84	15.34	13.96	11.56	13.06
1934	26.87	41.93	62.67	54.49	79.44	84.90	61.30	74.73	93.31	90.90	43.07	28.84	24.89	21.54	19.47	16.01	16.29	13.66	11.16	10.72	10.87	10.58	8.88
1935	8.30	17.57	15.20	16.33	15.51	22.26	68.59	69.60	59.43	50.57	38.04	29.71	26.41	25.46	27.50	23.19	19.36	17.16	13.24	15.37	10.06	8.69	7.29
1936	10.91	9.68	22.20	25.13	36.40	53.17	37.34	48.16	51.54	33.53	29.76	26.53	20.74	18.26	14.93	13.74	11.29	10.22	9.66	9.15	6.98	6.58	6.06
1937	5.16	5.57	6.80	16.97	25.71	30.97	32.40	46.69	39.30	117.29	113.59	61.50	38.71	23.39	22.43	16.34	15.19	12.17	11.17	9.99	9.27	10.54	7.10
1938	7.27	15.43	18.61	25.36	21.30	35.86	77.63	121.53	82.84	50.73	61.27	64.33	51.61	29.24	22.17	19.29	14.16	12.53	11.26	11.10	10.01	15.76	13.74
1939	7.16	10.34	20.06	37.24	32.60	36.89	36.00	35.24	26.20	26.17	25.44	20.71	21.94	18.70	18.83	17.56	16.87	13.31	8.47	8.59	8.43	7.83	6.17
1940	3.90	5.91	12.99	17.16	25.50	35.54	38.36	38.19	34.71	33.24	28.91	21.94	19.74	17.86	14.53	13.26	13.46	9.54	7.84	5.93	6.72	7.69	6.41
1941	4.58	7.72	9.65	21.73	19.73	19.29	16.99	19.01	21.10	17.06	18.31	21.33	19.83	19.94	16.63	13.13	11.12	10.03	8.65	7.37	6.48	7.54	10.25
1942	7.85	10.60	20.20	15.03	24.09	24.79	33.49	44.90	105.14	84.70	57.97	51.07	54.61	37.07	23.50	23.59	20.90	18.24	16.47	13.77	11.51	9.98	10.10
1943	16.71	34.84	40.57	38.30	40.31	37.77	60.07	96.16	79.64	75.97	133.43	89.13	88.19	66.46	36.64	36.99	27.89	21.36	15.26	17.20	15.89	13.50	10.78
1944	3.46	4.11	3.96	9.25	15.09	24.94	31.03	25.19	26.21	26.19	23.36	27.11	22.77	18.19	14.34	12.06	11.27	12.27	11.93	12.97	10.63	9.53	8.77
1945	3.07	3.95	5.15	9.75	35.77	34.69	35.76	56.27	91.63	57.86	61.49	63.27	36.17	32.63	23.94	17.07	15.27	12.31	10.81	8.03	6.51	8.56	11.01
1946	7.30	12.47	24.56	32.83	36.40	43.00	41.70	57.80	54.83	44.14	47.14	36.86	32.74	33.90	24.59	19.64	16.33	14.04	11.01	10.40	12.47	13.00	12.37
1947	24.23	28.99	35.01	59.81	70.30	69.39	49.11	54.30	60.99	64.30	37.66	41.44	35.71	34.21	24.57	20.26	16.57	14.29	12.44	13.30	12.84	10.21	7.90
1948	4.09	23.47	27.53	47.14	47.86	34.19	118.11	138.57	160.71	121.40	191.43	110.00	53.03	24.07	19.89	21.73	24.91	16.83	15.24	13.94	12.63	11.89	10.01
1949	7.52	9.47	13.66	19.91	27.59	55.51	47.20	57.36	54.17	49.23	25.27	27.60	19.06	20.99	18.86	16.99	15.19	13.01	8.83	8.05	6.59	7.45	7.58
1950	13.67	17.49	17.44	18.81	23.50	66.71	80.27	95.43	111.63	106.33	129.86	117.14	95.61	70.11	54.11	40.61	30.91	26.59	20.60	19.09	19.54	14.81	10.15
1951	13.89	18.56	24.74	70.76	91.03	109.43	105.70	72.97	49.67	79.86	116.66	121.66	102.37	87.39	64.64	44.54	32.54	26.76	20.74	17.46	27.33	27.21	41.94
1952	10.99	25.10	39.21	61.50	55.07	58.57	64.29	57.44	55.06	73.73	59.04	42.43	42.11	30.84	22.81	20.64	19.01	20.76	17.30	13.29	11.60	9.05	8.75
1953	5.35	10.47	26.40	37.66	52.76	42.26	76.89	129.63	201.57	174.57	119.33	65.21	76.16	79.27	71.93	32.74	25.61	23.37	20.89	16.79	14.31	13.70	12.56
1954	11.82	17.43	23.74	24.51	46.33	94.71	151.43	108.04	92.44	77.16	64.11	79.34	74.40	90.60	72.50	41.81	23.24	20.96	18.13	17.47	25.43	35.33	16.16
1955	7.25	6.00	6.68	11.17	15.01	35.40	53.84	54.13	75.93	98.03	95.14	111.49	52.67	38.14	52.23	36.36	21.64	17.06	15.90	14.39	11.60	10.37	11.47
1956	5.91	10.91	16.11	16.21	17.20	29.89	129.60	136.43	119.73	71.10	59.33	41.06	39.70	35.99	31.37	26.16	19.43	14.83	18.31	15.21	14.20	12.70	9.16
1957	3.56	5.39	8.25	37.41	84.80	69.47	77.54	78.70	90.61	80.69	41.50	23.63	16.81	17.38	18.73	15.11	14.31	12.10	10.28	8.57	7.07	6.25	5.22
1958	8.46	8.60	9.46	12.02	45.56	59.26	62.59	61.20	68.27	70.81	53.91	39.76	24.99	21.69	18.87	17.96	17.56	13.23	11.41	9.59	8.84	6.14	6.61
1959	11.77	16.20	16.29	31.69	30.37	47.91	64.96	60.99	108.86	90.56	81.93	62.30	39.80	33.90	37.56	31.31	21.33	17.57	14.31	13.86	15.56	17.39	28.97
1960	16.36	14.46	14.73	12.94	17.31	40.31	23.44	31.19	73.50	50.56	58.17	43.37	33.80	28.11	26.53	23.10	20.81	19.03	13.99	12.07	9.34	9.25	6.79
1961	9.65	8.52	9.20	11.91	19.01	25.93	59.36	92.63	65.26	63.47	69.06	47.26	25.51	26.14	24.77	20.60	15.40	14.69	12.01	9.69	9.45	8.63	6.86
1962	9.12	15.06	28.40	21.91	19.91	30.37	43.24	45.16	34.26	41.91	45.91	38.67	27.14	22.69	21.71	19.31	20.69	17.06	13.03	9.71	10.83	11.06	9.25
1963	6.83	8.68	9.02	19.03	21.77	28.91	37.13	49.41	65.37	67.19	51.16	34.46	43.00	33.67	23.94	18.04	13.67	12.91	13.09	10.77	7.82	7.67	6.96
1964	3.81	3.13	4.89	19.23	20.34	32.10	53.31	39.80	174.90	271.00	123.61	74.79	58.54	57.19	50.96	25.39	15.87	10.03	12.04	10.55	10.11	12.06	12.53
1965	9.16	11.63	27.59	39.96	33.11	72.93	70.91	63.86	84.11	84.14	121.24	75.67	54.01	40.83	36.87	27.59	23.64	19.13	17.74	14.99	13.20	11.21	12.50
1966	18.00	19.29	17.59	15.14	51.73	41.17	33.76	75.46	93.11	59.96	46.69	38.16	39.17	46.36	33.70	19.59	17.39	15.64	12.83	13.60	11.78	10.34	8.42
1967	6.42	5.86	6.65	7.75	40.27	70.91	136.33	150.43	125.43	105.29	99.63	76.87	68.21	44.90	33.49	24.84	20.93	18.86	15.57	13.84	10.71	8.84	8.78
1968	6.59	6.17	7.33	11.91	20.51	26.96	48.33	50.59	65.16	60.17	44.61	40.77	30.31	34.83	24.73	21.77	18.33	16.74	17.60	15.61	12.77	13.89	13.71
1969	14.69	21.39	33.17	30.14	35.13	48.51	37.29	49.77	75.00	57.66	32.76	91.79	55.07	31.81	19.97	18.87	15.67	11.09	10.23	9.10	8.60	6.48	7.90
1970	9.12	5.25	5.36	11.28	37.69	45.79	64.31	63.71	105.91	139.57	109.23	69.21	33.49	26.39	21.84	19.07	17.63	15.96	12.27	10.56	8.14	6.21	9.29
1971	6.74	9.42	22.96	37.34	66.46	72.79	59.54	142.71	115.71	94.40	56.20	70.10	48.41	33.37	40.17	39.87	24.64	21.06	17.11	13.39	14.33	13.56	10.46
1972	16.94	15.67	17.09	21.86	21.63	72.49	128.00	111.14	113.86	117.37	71.70	42.16	38.41	41.07	55.86	40.24	34.13	25.74	22.09	18.20	15.34	13.27	12.39
1973	4.68	5.44	8.55	10.14	15.13	38.36	46.76	34.30	47.41	49.64	31.04	39.63	25.37	21.20	17.91	14.93	13.26	13.54	11.30	10.71	10.57	7.20	6.24
1974	7.15	9.08	20.93	38.21	47.44	25.54	25.23	49.69	58.61	96.66	143.71	106.21	75.29	55.36	47.86	38.14	26.00	23.79	20.83	19.37	17.43	13.66	12.81
1975	2.98	3.54	5.59	10.01	27.61	55.23	56.84	59.29	143.00	102.90	304.43	151.50	113.33	106.66	60.49	33.10	28.29	18.60	16.50	20.13	22.53	19.99	20.01
1976	14.99	23.24	16.26	22.89	57.33	76.01	48.09	51.99	34.30	40.86	39.23	34.44	33.27	44.91	38.90	26.07	22.80	23.21	22.16	22.96	23.49	16.49	14.54
1977	4.63	5.50	11.10	27.21	24.91	26.56	17.94	20.74	31.53	25.33	19.87	16.90	17.74	12.81	13.41	17.27	15.53	11.53	13.81	14.76	15.49	19.97	20.61
1978	11.04	10.58	14.49	33.19	40.93	58.63	78.80	58.06	84.57	73.00	50.19	62.03	65.00	46.77	50.83	33.11	28.44	21.20	18.29	24.33	24.43	27.33	40.46
1979	10.03	11.91	15.40	25.80	38.59	57.16	98.53	89.43	66.37	52.04	42.19	35.20	31.30	26.94	19.90	20.40	14.84	12.00	9.46	9.56	10.68	12.02	14.19
1980	4.52	7.18	17.41	44.70	52.90	40.21	62.10	68.11	38.29	47.69	46.77	28.83	24.51	22.44	19.21	16.84	14.31	12.76	12.07	13.54	10.13	9.91	16.99
1981	5.70	9.02	22.47	32.60	25.14	39.44	86.60	71.71	49.73	39.20	34.66	43.16	45.91	30.06	25.40	22.09	19.40	15.07	14.51	12.21	9.67	9.41	7.34
1982	5.26	8.24	11.46	12.07	15.51	30.33	68.34	74.23	59.99	76.16	82.90	77.30	81.84	53.19	44.41	47.61	35.80	20.61	16.89	13.44	10.99	9.11	8.57
1983	3.64	2.90	7.92	13.60	20.07	20.26	37.23	55.77	39.59	30.30	30.54	28.24	28.56	30.91	31.76	21.91	18.39	16.49	15.17	9.54	10.25	10.07	8.40
1984	2.87	8.14	17.86	12.63	11.19	24.51	32.80	37.11	35.29	31.09	44.19	47.57	35.70	24.07	20.51	18.77	18.57	14.26	11.66	13.51	9.71	7.12	8.42
1985	5.79	18.77	14.07	31.21	28.57	25.41	55.30	56.77	54.33	50.90	32.06	21.69	29.71	23.69	17.89	15.49	11.81	9.25	11.99	14.36	11.57	10.40	25.64
1986	15.19	14.46	27.79	21.14	21.69	22.80	40.43	118.64	63.36	53.36	34.09	24.26	23.96	19.81	16.64	18.09	13.84	12.57	11.54	8.61	7.20	12.79	11.91
1987	13.16	18.11	20.33	48.36	44.24	43.59	27.44	45.66	36.56	36.74	29.39	12.57	18.37	14.51	22.26	51.26	23.47	15.97	16.17	18.31	20.23	17.93	15.51
1988	12.30	21.81	21.23	18.66	26.31	42.94	37.99	36.71	37.11	32.61	28.39	26.07	19.04	16.89	14.39	8.96	7.14	7.44	6.85	7.20	5.97	5.22	4.70
1989	4.47	20.56	28.74	19.07	54.00	37.54	28.37	28.17	59.51	103.50	50.81	30.97	24.97	31.04	33.97	22.94	17.66	14.60	13.09	16.24	25.63	20.71	15.86
1990	15.84	21.49	34.09	28.83	36.50	21.47	30.50	69.61	50.69	46.66	56.78	77.96	61.53	40.50	29.56	23.04	22.91	17.40	14.59	14.66	12.83	10.05	7.27
1991	14.67	11.56	19.29	16.53	19.40	68.11	120.43	68.37	88.38	90.77	106.19	93.91	93.69	58.01	44.73	28.39	22.56	21.50	17.04	13.96	11.47	9.66	9.63
1992	8.88	10.57	15.39	27.07	30.06	23.31	27.20	29.04	26.07	32.80	41.13	30.63	22.26	21.40	17.64	14.68	13.67	10.59	8.38	9.50	10.95	7.91	6.69
1993	9.06	7.46	9.01	11.96	18.84	50.64	48.19	35.03	32.16	31.30	33.93	27.64	34.77	36.90	29.90	26.97	18.60	16.41	18.70	18.66	15.70	16.40	17.69
1994	11.64	17.97	42.51	28.47	36.94	55.00	42.53	49.69	43.29	38.47	29.24	33.10	24.63	19.27	17.27	17.41	13.57	10.72	8.73	6.97	6.59	4.32	5.66
1995	7.02	3.62	5.08	13.17	30.07	37.43	39.84	55.90	195.47	121.07	101.09	100.10	79.13	65.50	43.49	43.53	37.34	31.36	28.43	27.09	29.03	29.66	24.84

Appendix 2. Actual weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, from Alberta Environment (2001). (page 6 of 6)

LSTM = St. Mary River at Lethbridge (Station 05AE006)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	26.11	26.56	27.60	32.67	45.37	66.13	68.33	60.49	52.23	68.89	51.06	63.09	51.53	50.79	33.73	52.91	50.44	26.24	20.11	16.31	13.74	14.10	12.90
1913	40.33	37.46	37.50	35.07	30.46	41.46	64.64	154.57	152.00	122.43	87.84	87.84	82.00	55.81	36.31	34.06	33.86	31.40	30.17	21.34	16.50	13.97	10.25
1914	13.57	24.76	33.59	44.90	46.49	51.83	63.69	53.99	53.76	53.39	53.04	39.94	33.07	40.00	27.57	15.64	13.49	9.03	6.47	14.39	10.90	7.88	7.79
1915	13.43	21.29	28.94	37.39	50.29	70.51	42.89	40.03	97.49	71.84	71.17	86.23	67.39	51.94	41.99	57.60	49.06	31.10	26.77	27.87	22.04	32.00	25.93
1916	23.67	23.07	24.26	30.31	59.46	46.30	58.43	82.44	90.69	113.23	207.00	196.71	183.29	134.29	98.63	65.89	52.67	48.59	38.54	34.54	29.14	35.36	36.10
1917	48.77	25.36	22.23	19.74	20.76	79.61	104.04	132.57	111.07	148.00	137.57	110.01	81.23	73.54	50.30	33.61	18.81	13.03	10.72	5.82	6.48	5.66	4.86
1918	19.20	25.53	27.94	36.84	86.43	65.10	37.97	26.63	38.59	123.76	93.84	50.20	19.19	9.91	7.19	5.61							
1919	9.01	7.74	5.83	26.26	21.23	14.36	49.07	87.04	32.44	14.12	9.34	14.67	7.82	2.51	1.08	0.60	1.28	1.25	3.15	0.72	0.77	0.70	0.92
1920	23.61	36.10	20.83	27.07	62.13	78.31	85.27	52.10	48.83	87.54	101.16	60.59	41.59	29.99	44.70	42.04	24.94	10.99	5.72	1.96	1.54	1.89	1.43
1921	17.39	25.60	25.84	16.80	41.50	52.26	94.99	95.41	99.73	98.83	66.69	38.00	30.87	15.74	11.24	5.46	3.26	1.96	1.29	2.52	1.61	1.66	2.30
1922	4.30	8.91	16.29	41.11	32.90	41.79	78.06	89.03	115.86	102.57	80.86	44.27	21.26	31.63	16.73	24.97	9.01	2.00	1.96	6.11	1.98	2.02	3.21
1923	10.61	13.87	16.59	23.66	33.26	55.26	54.49	74.01	92.21	80.29	65.91	53.03	37.10	21.40	22.30	15.97	7.49	4.62	3.34	12.16	15.24	20.26	24.84
1924	16.79	11.23	10.67	13.10	24.14	51.97	47.04	27.63	42.21	76.07	80.21	62.36	58.53	42.90	14.54	8.11	5.40	6.57	4.97	3.71	2.36	1.71	1.56
1925	37.19	49.31	52.91	42.51	51.59	61.90	107.14	93.39	57.29	53.17	75.11	78.13	53.73	19.98	5.24	4.84	4.82	3.44	4.77	7.38	4.96	7.07	2.47
1926	5.67	9.14	15.86	14.69	11.39	5.13	5.01	2.45	1.04	1.28	13.82	11.63	8.85	4.99	1.63	1.21	0.95	1.20	1.01	0.71	0.73	4.94	14.04
1927	8.55	13.54	30.53	67.64	46.80	63.61	187.43	193.86	156.14	202.14	167.29	129.14	86.04	72.20	56.24	42.43	26.81	16.70	17.64	27.01	22.64	25.54	56.27
1928	16.43	19.39	27.59	39.31	70.60	119.29	124.29	121.63	54.89	36.29	72.37	97.19	154.14	85.74	68.93	44.10	35.76	23.19	10.72	5.21	18.43	8.00	4.83
1929	12.46	16.80	21.79	24.04	24.93	35.53	67.63	80.46	91.50	93.10	57.61	25.14	24.00	23.20	7.38	4.90	2.65	2.29	1.80	1.34	0.88	1.26	1.16
1930	26.87	38.56	50.97	72.73	60.67	43.64	55.73	53.11	64.99	59.30	30.64	18.01	9.52	2.77	5.77	3.51	1.35	0.92	0.81	0.98	0.92	0.88	1.35
1931	2.65	1.72	1.63	2.82	16.50	29.43	24.16	22.57	22.33	16.50	8.23	1.89	1.86	1.69	1.08	0.47	2.10	1.85	0.99	0.70	1.35	0.80	2.55
1932	10.48	7.40	20.59	15.39	23.60	47.90	82.64	41.70	45.04	42.64	71.19	51.83	29.74	12.29	2.49	1.20	0.53	0.52	0.64	1.53	0.98	0.83	2.94
1933	8.11	11.80	19.34	27.67	48.56	47.13	46.43	78.56	110.86	87.96	71.86	45.20	32.73	29.60	16.32	4.10	0.67	0.87	0.46	2.34	1.97	2.12	1.16
1934	31.74	42.67	65.43	50.80	71.86	71.86	48.46	51.73	90.50	105.30	42.80	24.26	18.64	10.91	3.22	1.57	0.79	0.70	0.64	0.65	0.71	0.90	1.17
1935	9.02	31.59	18.49	19.71	14.24	14.24	56.26	62.93	50.21	31.16	20.24	7.97	4.60	3.56	5.73	4.39	2.37	2.57	2.23	3.42	2.04	1.04	0.68
1936	27.17	11.63	19.83	25.61	31.31	41.71	29.37	22.79	51.99	21.91	14.23	4.02	2.11	0.64	0.27	0.03	0.10	0.27	0.25	0.49	1.22	0.69	0.83
1937	15.67	6.34	4.50	4.93	10.83	8.82	17.00	28.16	26.53	122.59	104.89	49.77	12.31	2.41	4.97	1.48	1.56	1.57	1.10	1.08	0.99	1.64	1.21
1938	19.65	9.04	10.66	15.34	12.31	28.11	74.37	125.86	60.67	33.94	33.49	44.91	41.06	14.28	2.69	3.10	1.53	1.11	1.42	1.48	1.11	3.76	8.49
1939	6.40	8.04	9.52	18.37	11.27	9.56	24.21	22.06	19.27	27.59	28.81	20.04	17.23	8.97	2.09	0.59	0.54	0.58	0.51	0.42	0.42	0.56	0.58
1940	4.22	3.45	12.40	15.39	16.51	27.13	26.20	23.16	12.97	6.57	3.15	1.82	1.25	1.40	1.03	1.03	2.27	1.04	0.45	0.43	0.26	0.63	0.88
1941	4.68	7.79	4.66	8.84	11.29	3.93	2.65	11.88	24.71	10.77	2.77	4.55	6.11	2.31	1.48	0.89	0.78	0.42	0.25	0.19	0.65	0.93	1.10
1942	12.82	11.72	12.61	6.62	15.25	27.34	25.56	49.41	123.53	95.59	61.46	58.09	51.37	27.93	10.29	12.63	21.36	14.46	8.53	2.22	2.26	3.99	2.47
1943	25.31	36.26	43.04	40.11	40.53	36.24	52.34	92.81	84.59	67.96	120.86	86.16	76.91	61.76	20.24	16.24	7.06	5.25	1.38	0.73	2.51	1.79	0.92
1944	4.71	0.83	0.26	0.17	0.21	0.26	10.31	2.45	6.59	8.50	7.91	7.49	4.11	4.17	1.74	0.37	0.19	0.79	0.60	0.69	0.55	0.51	0.28
1945	2.33	1.47	1.99	2.32	22.83	27.44	23.21	43.49	105.94	76.80	59.43	69.61	34.97	15.19	4.17	1.04	0.66	0.53	0.50	0.34	0.24	0.14	0.37
1946	7.69	10.70	17.61	20.71	15.33	18.96	16.96	45.53	50.94	37.79	30.69	26.00	15.13	18.06	7.32	0.95	0.30	0.12	0.09	0.23	0.47	0.77	0.88
1947	27.07	33.53	35.96	58.53	77.40	73.61	46.69	45.89	53.37	63.31	44.87	32.69	20.11	11.23	4.25	1.32	0.70	0.80	0.69	6.71	10.73	9.77	5.84
1948	7.56	64.59	44.37	52.77	75.31	51.93	120.51	144.86	154.00	129.14	212.29	114.74	52.33	17.04	3.86	4.71	14.14	7.71	3.92	2.43	1.29	1.12	1.18
1949	12.32	5.09	3.24	2.68	1.99	34.63	46.64	52.16	49.16	38.71	21.86	6.89	2.35	1.57	1.40	1.25	1.26	0.64	0.49	0.47	0.51	0.56	0.71
1950	20.44	23.16	10.04	11.93	18.03	62.03	75.87	87.30	102.00	91.41	106.81	109.06	66.73	58.71	40.43	26.20	12.68	9.36	3.04	1.76	2.66	0.34	0.72
1951	31.99	27.20	26.80	41.94	37.29	45.91	69.20	96.03	92.46	84.10	84.64	78.94	91.90	107.31	83.09	75.71	77.67	76.56	77.34	53.41	53.60	62.46	40.76
1952	7.26	1.48	19.51	30.73	32.59	38.43	36.97	16.18	40.87	61.00	55.34	35.71	31.70	38.01	41.46	38.74	33.63	35.97	38.29	36.33	21.87	10.38	9.94
1953	0.70	1.83	5.33	6.80	5.23	2.23	1.85	148.94	323.43	225.43	120.59	56.94	28.94	52.76	62.96	32.07	42.27	12.93	25.96	54.06	37.30	14.54	9.82
1954	19.14	15.61	15.17	11.32	27.73	27.36	147.71	104.43	82.64	69.94	12.40	9.74	6.39	5.65	16.14	8.50	5.34	11.03	9.82	10.14	11.46	12.75	32.76
1955	35.47	7.48	15.88	33.60	22.43	38.23	32.06	34.26	32.89	34.19	3.01	47.64	81.01	33.94	19.80	24.39	22.23	14.51	9.98	9.40	8.72	8.20	7.52
1956	7.85	6.41	1.18	1.92	15.11	2.02	15.18	56.55	74.55	3.49	5.02	1.59	54.78	37.10	24.26	27.44	41.81	20.16	14.45	18.40	17.87	26.50	20.97
1957	6.22	5.95	8.11	5.22	5.63	5.04	30.91	7.73	12.03	55.43	28.77	9.31	5.07	4.51	4.41	4.12	3.93	2.90	2.26	1.82	1.73	1.81	1.54
1958	35.84	8.69	2.07	1.25	0.87	1.01	1.21	1.48	2.20	65.14	23.93	32.40	23.17	6.52	4.81	4.42	3.49	2.99	2.88	2.56	2.08	1.03	1.14
1959	12.19	10.50	1.20	1.64	1.15	5.94	77.03	74.84	86.79	75.37	8.39	20.05	35.30	8.06	8.19	6.53	4.95	4.56	4.39	3.93	2.42	2.38	1.79
1960	21.33	10.83	19.96	21.27	22.87	28.53	37.37	9.05	18.40	19.93	3.38	3.03	2.99	2.77	2.89	2.64	3.11	2.56	1.81	1.28	1.20	1.19	0.98
1961	0.97	0.71	0.79	1.15	1.64	1.69	1.34	1.31	1.71	1.09	1.67	1.00	1.31	1.30	1.62	1.70	1.41	0.95	0.95	0.80	1.38	1.78	1.79
1962	12.96	13.21	10.61	4.25	1.43	1.30	1.25	1.27	0.83	1.64	1.05	1.02	1.19	1.28	1.51	1.52	1.48	1.32	1.29	1.29	1.29	1.45	1.03
1963	0.70	0.69	0.56	0.60	0.71	0.68	0.60	0.74	0.92	1.06	5.26	17.14	25.00	29.97	21.34	3.61	3.18	2.60	1.70	1.34	1.15	0.78	0.93
1964	2.31	1.68	2.30	15.92	86.96	97.46	72.37	26.50	51.80	303.29	102.74	9.31	9.17	10.43	10.05	8.89	7.89	6.03	3.34	1.59	1.04	1.12	1.26
1965	41.67	30.13	29.97	46.69	50.40	56.31	87.30	95.93	88.73	51.34	67.10	107.99	69.17	35.47	44.73	41.37	8.97	8.65	7.80	7.82	7.04	6.93	6.94
1966	34.70	27.49	25.14	18.43	25.47	61.21	55.30	24.71	100.07	76.74	23.76	8.46	10.34	53.83	62.86	8.17	5.28	5.43	5.81	6.21	5.57	4.76	4.61
1967	45.10	29.31	21.36	26.43	77.96	123.86	152.43	161.57	160.86	142.57	119.71	34.29	13.67	34.81	21.26	5.58	2.42	3.07	2.13	2.28	2.43	2.52	2.50
1968	4.30	2.09	2.25	2.69	2.56	2.88	5.86	39.07	57.37	68.03	30.31	3.62	3.97	3.23	3.46	3.50	3.05	2.91	2.64	15.79	18.37	16.57	28.46
1969	36.33	4.95	6.85	27.39	26.49	32.01	27.77	20.66	8.52	20.61	4.36	79.87	57.79	38.17	21.26	13.00	9.31	5.28	36.21	11.79	1.82	1.71	1.98
1970	1.75	1.76	1.83	8.55	52.51	37.90	27.73	2.95	3.00	51.77	61.21	47.94	50.03	16.49	16.00	15.13	13.21	10.42	8.84	7.69	4.49	2.51	2.84
1971	9.68	9.75	11.29	11.07	23.47	35.11	45.90	117.46	129.71	65.70	10.67	7.35	18.38	18.67	11.49	10.44	8.76	7.57	7.03	6.57	6.71	6.24	6.03
1972	34.26	27.43	23.49	25.43	52.69	50.53	96.10	117.43	116.29	126.00	61.44	6.50	4.20	4.06	7.50	27.03	19.51	5.53	3.88	21.70	27.29	1.82	1.82
1973	2.24	2.25	2.31	2.33	2.37	2.50	3.82	3.54	3.26	9.04	17.51	7.90	5.84	2.92	3.35	3.26	3.05	3.26	3.30	2.96	4.26	4.39	3.73
1974	2.55	5.62	10.76	33.19	37.94	34.36	17.79	21.19	31.79	41.71	80.34	31.14	11.80	15.98	10.88	6.43	4.09	4.54	4.60	16.57	19.51	20.56	19.76
1975	1.74	6.60	16.37	24.49	53.80	66.14	96.36	61.60	101.94	116.57	414.00	190.14	97.99	119.00	46.97	11.37	15.50	10.14	9.90	9.76	9.67	28.47	43.90
1976	5.03	2.61	2.82	2.99	2.80	14.91	43.17	17.91	5.41	3.90	4.36	4.15	3.57	10.40	15.09	7.19	3.19	30.70	32.97	32.87	33.44	13.48	6.54
1977	2.61	1.05	0.73	1.05	2.08	3.10	2.47	2.38	2.57	2.75	2.71	2.82	2.75	2.91	2.53	2.98	2.49	2.32	2.32	2.55	1.92	1.91	1.83
1978	3.34	4.06	3.03	3.17	3.38	26.05	78.83	76.66	75.04	79.96	33.06	20.47	28.44	14.14	13.05	10.93	6.75	5.81	6.10	14.55	47.76	57.23	57.64
1979	23.50	27.09	28.39	32.11	45.99	52.29	66.91	95.01	39.95	10.42	4.95	4.59	4.35	4.57	4.77	5.35	4.86	4.48	4.34	6.01	3.94	3.02	3.73
1980	2.70	4.39	3.31	2.46	2.53	2.74	7.84	95.53	41.80	74.77	63.19	9.99	6.92	9.79	8.35	7.15	14.29	9.46	3.17	2.89	2.41	2.29	2.66
1981	1.26	1.06	1.30	0.99	1.39	53.08	166.07	54.79	17.06	59.28	58.30	5.15	3.48	3.59	3.54	3.91	3.47	6.62	3.05	3.04	2.68	2.74	2.94
1982	25.01	8.75	6.68	5.15	4.72	4.33	4.80	48.84	33.27	47.41	20.55	8.47	49.24	10.97	13.06	21.63	12.94	4.01	3.13	2.96	3.11	2.68	2.76
1983	2.65	1.92	3.40	2.52	2.18	2.08	16.58	3.64	2.39	2.11	2.41	3.21	3.19	2.59	3.69	2.13	2.35	3.14	3.35	2.53	2.44	2.32	2.16
1984	1.31	1.38	1.31	1.05	1.21	1.47	1.73	2.15	1.84	1.97	1.98	1.63	2.34	1.94	2.00	2.44	3.52	2.87	2.67	2.32	2.09	2.87	2.05
1985	0.91	1.14	1.59	1.44	4.17	22.96	18.16	17.44	5.79	5.27	1.84	1.66	1.69	2.63	3.51	3.53	3.12	2.58	3.08	2.51	1.26	2.27	4.22
1986	11.79	12.16	6.91	4.43	19.69	31.90	40.50	40.03	37.84	3.94	6.68	3.17	3.19	2.79	3.18	2.63	3.35	4.62	4.99	4.73	4.70	2.88	1.80
1987	2.00	1.78	1.89	1.64	2.02	2.35	2.62	6.42	13.23	5.67	7.62	2.83	3.66	4.40	5.81	6.97	3.88	4.40	4.61	12.94	41.83	39.10	37.14
1988	1.03	1.24	1.65	1.83	2.46	2.27	1.86	2.32	2.31	2.35	1.83	2.97	4.28	4.10	4.50	5.15	5.71	4.50	2.99	2.93	2.91	3.12	4.35
1989	1.92	1.63	1.82	1.52	1.19	1.59	1.81	2.93	2.23	3.39	2.29	2.86	2.55	3.73	3.18	3.13	3.92	2.88	2.13	1.85	5.71	15.67	25.27
1990	11.56	11.16	17.51	26.50	25.61	18.93	12.40	53.16	54.63	22.40	17.39	13.56	8.34	11.88	4.54	4.61	4.20	3.82	4.02	3.89	3.94	4.05	3.40
1991	7.92	5.32	2.78	2.90	4.13	36.94	156.71	72.89	47.59	37.90	113.02	123.94	121.71	51.03	18.83	6.82	6.75	6.55	17.29	18.66	10.79	4.79	4.25
1992	2.75	2.88	3.13	5.30	5.35	4.32	4.27	4.32	5.01	6.92	3.75	5.95	6.62	7.12	8.01	7.88	8.28	5.23	4.51	6.98	4.85	4.52	4.76
1993	5.45	5.15	5.90	5.26	7.32	23.18	46.07	9.98	30.86	61.31	69.43	34.96	44.50	85.79	90.69	45.19	39.27	37.00	42.43	46.23	24.00	28.76	33.06
1994	6.64	4.65	5.53	5.46	18.61	36.50	75.91	44.10	37.23	34.19	15.04	5.99	6.82	7.43	7.74	7.20	6.79	6.12	5.31	5.45	5.56	5.36	4.58
1995	3.72	3.57	3.65	4.10	9.64	25.73	64.81	59.59	271.93	151.29	85.07	91.84	89.73	57.47	25.90	48.73	33.74	24.53	13.90	10.76	10.50	11.17	10.19

Appendix 3. PRC weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, calculated using data from Alberta Environment (2001). (page 1 of 6)

UBEL = Belly River at Mountain View (Station 05AD005)

Week

Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	4.30	3.99	4.30	5.49	9.79	20.14	15.69	18.14	17.27	16.99	16.24	14.40	12.10	10.89	12.13	16.37	10.01	8.45	6.68	4.81	5.45	4.89	4.65
1913	3.19	6.26	6.66	5.49	9.26	13.52	25.60	50.00	42.63	33.10	22.80	32.39	22.61	16.74	8.62	11.42	11.09	16.26	11.69	7.95	6.86	6.18	4.64
1914	2.99	7.55	9.59	14.75	14.09	23.64	22.96	18.14	17.27	18.79	16.24	14.40	14.67	13.97	9.38	7.78	7.59	5.83	6.87	8.07	5.20	3.72	3.78
1915	4.28	9.45	5.85	13.02	16.93	13.52	14.03	18.14	21.63	16.99	16.24	22.57	17.06	10.19	11.67	11.65	14.60	10.21	9.38	8.80	7.74	8.23	7.13
1916	4.73	5.52	4.95	10.75	18.70	11.11	15.44	17.41	18.24	33.33	50.00	48.10	43.73	39.14	27.30	19.15	13.39	14.40	13.27	11.10	8.83	14.90	7.22
1917	1.97	2.51	2.91	4.01	9.79	30.49	29.20	30.38	39.97	42.37	37.31	27.65	26.93	24.73	20.48	12.41	7.16	6.56	6.76	6.85	5.37	3.72	3.63
1918	6.19	6.41	7.61	19.43	19.03	14.43	11.40	13.93	17.27	37.49	20.31	14.40	12.10	9.08	8.62	7.78	7.15	6.50	7.64	5.61	6.09	5.27	5.37
1919	2.05	3.40	5.00	12.19	9.79	13.52	37.63	33.03	17.27	15.81	16.24	14.40	11.54	9.08	8.62	7.78	7.15	5.83	5.07	4.21	3.89	3.72	2.86
1920	1.96	2.07	3.27	4.34	9.79	19.34	20.54	15.87	18.06	40.05	39.21	24.12	34.66	26.53	25.75	17.20	12.51	10.09	9.50	6.08	5.66	4.52	5.86
1921	5.10	11.06	5.68	5.49	16.64	18.11	41.20	30.13	39.33	31.99	23.97	25.84	18.55	15.57	12.52	10.63	9.31	6.69	6.92	4.69	4.32	3.96	3.53
1922	1.97	2.51	3.32	9.12	9.79	26.80	31.50	32.67	40.72	30.17	27.47	18.11	21.30	20.42	11.56	7.78	7.79	6.92	5.07	4.28	5.03	4.55	3.53
1923	1.97	4.33	4.58	5.49	16.29	13.52	25.86	36.74	46.03	31.08	26.03	21.20	15.04	12.92	13.05	10.35	7.72	5.83	5.29	12.79	7.02	5.03	3.95
1924	1.97	2.51	3.27	6.36	14.20	31.22	15.44	18.14	23.73	31.20	26.74	15.56	23.93	12.07	8.62	8.25	8.32	9.82	10.22	7.99	6.34	4.93	4.27
1925	13.84	14.00	8.12	11.44	14.53	37.21	49.87	35.00	17.27	22.88	32.06	28.30	17.32	13.90	12.13	9.48	8.50	6.20	7.44	6.74	4.79	5.03	6.22
1926	3.23	15.16	8.53	12.82	9.79	8.93	8.63	6.96	8.78	8.28	14.56	13.09	10.28	8.99	6.84	5.82	5.36	4.70	4.31	4.21	5.97	11.41	9.98
1927	1.97	3.01	15.90	15.29	9.79	25.50	24.14	36.30	50.00	50.00	50.00	46.98	31.44	26.82	26.40	22.24	15.84	13.52	16.32	13.93	9.20	9.16	19.40
1928	2.42	2.51	5.31	10.92	24.55	33.93	42.31	30.60	17.27	16.99	31.11	45.53	37.27	22.28	15.88	15.19	12.97	9.43	7.11	5.72	7.56	6.35	4.52
1929	1.97	2.51	3.27	5.49	9.79	14.86	27.89	20.63	24.50	23.03	16.24	14.40	12.10	12.59	8.62	7.78	7.15	5.83	5.07	4.21	3.89	3.72	2.84
1930	10.62	13.30	23.09	27.14	14.81	13.52	25.08	20.46	20.69	16.99	16.24	14.40	12.10	10.06	9.82	7.78	7.15	5.83	5.07	4.21	3.89	3.72	4.05
1931	1.97	2.51	3.27	11.66	11.98	24.91	15.44	18.14	17.27	14.54	13.54	10.16	7.80	7.78	7.33	6.38	7.15	5.80	4.37	4.01	2.94	3.23	3.41
1932	3.97	3.76	3.82	5.49	24.03	33.13	28.53	18.14	17.73	24.35	25.06	20.41	12.91	9.08	8.62	7.78	7.15	5.83	5.07	5.39	3.89	3.51	3.28
1933	1.97	1.94	5.51	9.74	9.79	13.52	15.44	38.03	42.19	45.31	30.31	25.52	24.37	18.13	13.93	9.94	8.67	7.49	6.27	4.99	4.31	3.72	3.53
1934	14.93	15.94	31.17	27.14	34.56	32.18	21.20	25.24	45.56	29.14	16.24	14.40	12.10	9.08	8.62	7.78	7.15	5.83	5.07	4.21	3.89	3.72	3.53
1935	1.97	2.90	3.80	5.49	9.52	13.52	29.56	21.41	17.31	17.33	16.24	14.40	12.10	9.76	12.93	10.21	7.32	5.83	5.07	4.21	3.89	3.89	3.53
1936	3.50	11.28	9.04	10.21	21.96	31.77	15.44	22.42	17.27	16.99	15.30	14.06	10.42	8.74	7.87	7.04	5.76	4.81	5.07	4.10	3.07	3.69	3.26
1937	1.97	2.51	3.42	6.74	10.29	13.52	15.44	18.14	17.27	50.00	32.84	19.92	14.27	9.08	8.62	7.78	7.15	5.83	5.07	4.21	3.84	3.72	3.53
1938	2.10	12.35	7.69	14.21	10.18	24.35	35.61	45.89	27.79	22.49	28.38	22.03	21.89	15.10	11.56	9.17	7.15	5.83	5.07	4.21	3.89	3.72	3.53
1939	2.48	5.90	16.98	20.86	13.99	16.13	15.44	18.14	14.23	16.20	16.24	14.40	12.10	9.08	8.62	6.93	6.99	5.18	4.34	3.72	3.29	3.36	3.53
1940	1.97	3.84	4.94	8.28	15.06	15.92	15.44	18.14	17.27	16.99	16.24	12.49	10.28	8.61	7.52	7.78	7.15	5.03	4.17	3.64	3.39	3.49	3.53
1941	3.69	3.60	5.37	11.30	9.79	13.52	13.21	16.63	14.53	12.74	9.47	14.40	12.10	9.08	7.64	6.15	5.14	4.56	4.35	3.78	3.89	3.72	6.84
1942	4.58	8.18	12.34	5.49	17.85	13.52	26.11	18.14	44.55	16.99	16.24	31.13	23.09	13.59	8.62	8.05	7.73	7.64	5.46	4.56	4.24	4.43	4.64
1943	8.29	21.81	10.25	8.37	9.79	11.46	26.83	28.17	17.27	27.60	38.80	29.16	28.11	25.12	15.46	16.86	11.03	8.72	5.82	4.21	3.89	3.72	3.53
1944	1.97	2.25	2.95	5.49	9.39	13.52	15.44	18.14	17.28	16.11	16.24	14.40	12.10	8.52	7.00	6.45	5.55	4.67	5.07	4.21	3.89	3.72	3.53
1945	1.40	2.40	3.10	7.41	20.60	13.66	15.44	36.10	31.34	16.99	30.06	23.86	14.82	13.04	8.62	7.78	7.15	5.83	4.77	3.71	2.95	6.53	5.69
1946	4.46	7.63	18.49	17.03	17.40	25.65	23.84	31.41	26.47	19.36	21.33	14.40	13.67	15.01	10.21	7.78	7.15	5.83	4.92	4.21	3.89	3.72	3.64
1947	3.15	7.05	17.74	28.13	35.97	21.01	15.44	18.14	18.86	20.61	16.90	18.20	16.17	17.32	12.26	9.76	7.15	5.83	5.07	6.62	5.58	3.72	3.53
1948	1.76	5.25	7.33	7.49	9.95	13.52	50.00	49.41	50.00	46.04	50.00	29.66	20.91	9.73	10.36	10.73	17.73	8.93	5.97	4.40	4.36	3.72	3.53
1949	2.61	3.59	6.20	6.77	14.22	27.75	25.56	26.29	19.55	16.99	14.70	14.40	12.10	9.08	8.62	7.78	7.15	5.83	5.07	4.21	3.89	3.72	3.53
1950	1.97	2.92	3.27	4.16	8.79	25.40	18.09	23.57	34.89	39.97	50.00	38.10	42.36	29.87	20.34	18.23	14.83	9.96	8.06	6.68	5.99	5.58	4.36
1951	4.24	5.27	6.55	17.73	31.76	32.79	33.24	18.14	16.79	33.78	31.33	41.17	40.63	30.36	31.66	19.81	17.15	11.98	9.86	7.31	13.89	13.87	7.32
1952	2.51	7.70	14.70	18.00	9.79	17.19	16.63	18.14	17.27	16.99	16.24	14.40	12.19	9.12	10.02	8.48	7.73	13.24	10.28	6.26	4.65	4.37	3.53
1953	1.97	2.51	12.59	12.30	19.79	13.52	27.90	50.00	50.00	50.00	29.56	23.62	26.27	31.04	24.33	12.94	12.32	11.28	9.26	7.24	5.49	5.71	4.38
1954	2.05	3.42	3.27	3.87	12.33	42.32	47.52	26.61	22.36	28.21	28.10	35.80	36.63	36.21	29.70	17.55	13.12	11.04	10.15	9.03	11.82	7.26	5.75
1955	2.22	2.51	2.73	4.39	7.54	13.52	16.27	18.14	29.94	41.43	37.54	36.61	15.57	28.40	25.31	15.33	11.90	8.91	6.71	4.86	3.97	4.58	3.89
1956	1.97	5.96	5.90	5.38	7.85	16.77	50.00	42.19	33.59	24.49	24.34	15.43	20.12	19.85	16.07	14.86	10.12	8.55	7.54	6.38	6.51	4.84	3.81
1957	1.53	2.30	3.46	27.43	36.88	44.60	34.27	33.20	35.56	16.13	16.24	14.40	12.10	9.08	8.62	7.78	7.15	5.83	5.07	4.21	3.89	3.64	3.53
1958	2.38	3.83	3.27	5.93	26.83	25.84	30.14	21.76	27.27	23.35	17.35	15.35	12.10	9.82	8.62	8.87	8.00	5.93	5.07	4.21	3.89	3.72	3.53
1959	4.53	4.43	4.77	16.16	9.79	20.01	15.72	18.14	41.47	29.60	33.24	25.17	18.26	17.44	16.27	13.44	9.00	6.75	5.07	5.71	6.77	10.43	11.91
1960	8.50	4.97	3.61	5.49	10.78	22.24	13.07	18.14	27.70	17.94	16.24	16.77	13.24	13.34	12.76	9.63	9.62	8.30	5.32	4.21	3.89	4.62	4.08
1961	2.67	2.78	3.27	5.49	9.79	13.52	40.19	44.30	39.60	25.47	27.20	14.40	12.10	9.08	8.62	7.78	7.15	5.83	5.07	4.21	3.89	4.52	3.53
1962	3.35	10.66	16.43	6.57	9.79	13.52	16.59	20.05	17.27	21.96	19.70	15.16	12.10	9.08	8.62	7.94	8.20	6.39	5.07	4.21	3.89	3.92	5.50
1963	2.08	3.23	3.34	6.70	9.79	13.52	20.94	26.76	33.91	38.39	25.64	18.66	24.63	17.03	8.62	7.78	7.15	6.01	5.50	4.21	3.89	3.72	4.10
1964	1.97	2.51	2.06	8.13	10.01	17.67	26.17	18.14	50.00	50.00	36.87	32.60	25.47	24.37	15.65	10.84	9.48	7.10	6.08	4.21	3.89	5.37	4.44
1965	1.97	2.81	9.14	16.24	10.41	21.86	15.44	33.69	30.36	40.27	49.20	35.35	24.72	23.45	19.76	12.04	13.07	10.53	9.13	7.90	5.69	4.94	5.95
1966	7.56	5.40	4.56	7.03	25.24	13.52	15.44	43.19	36.16	26.13	21.01	17.69	16.38	17.64	14.70	9.92	8.10	7.04	5.22	8.42	7.45	5.94	4.85
1967	1.97	2.51	2.39	3.16	9.79	15.61	45.40	38.96	38.33	37.20	40.63	40.54	34.66	22.80	19.76	11.77	10.46	9.08	7.98	6.98	5.21	4.78	4.10
1968	1.97	2.51	2.98	5.69	9.79	13.52	26.01	23.51	28.16	23.60	18.13	17.89	13.73	18.97	10.82	9.90	9.00	7.43	8.96	8.59	6.29	6.66	6.50
1969	6.60	7.43	13.46	6.88	16.29	23.16	15.44	21.24	32.97	16.99	16.56	41.92	21.13	13.75	8.62	7.78	7.15	5.83	5.07	4.21	3.89	3.72	3.53
1970	1.97	1.89	1.76	5.49	15.42	23.30	37.57	27.57	47.04	48.85	42.54	26.40	12.51	10.86	9.38	7.78	7.15	6.04	5.07	4.21	3.89	3.72	3.53
1971	2.08	2.86	9.72	16.70	29.80	23.93	17.50	36.56	34.11	24.83	21.96	27.83	23.85	18.19	19.97	17.43	14.75	12.61	8.89	5.86	6.07	4.91	3.53
1972	6.11	3.43	3.76	6.86	9.79	34.36	39.44	47.36	50.00	45.93	26.21	19.46	20.61	19.26	20.58	24.34	19.66	15.81	12.09	9.63	8.51	6.40	6.09
1973	1.97	2.51	3.27	5.49	9.79	27.57	21.32	18.14	18.86	16.99	16.24	14.40	12.10	9.08	8.62	7.78	7.15	5.83	5.07	4.21	3.89	3.72	3.53
1974	2.07	3.49	11.16	15.49	23.15	13.27	15.44	21.44	25.07	46.80	50.00	44.07	26.04	21.99	22.11	18.97	15.11	11.69	7.43	6.61	6.37	4.73	5.13
1975	1.18	1.33	3.27	4.77	13.49	29.59	15.44	29.13	49.77	44.31	50.00	49.57	50.00	46.21	23.59	17.80	15.21	10.81	9.69	12.24	10.93	7.59	5.53
1976	8.16	7.22	4.03	7.90	33.37	30.83	21.96	18.14	16.44	16.99	16.92	14.40	19.24	21.46	15.61	14.63	12.13	13.63	12.62	9.36	8.46	6.60	4.62
1977	2.71	2.55	5.58	11.69	9.79	12.23	9.44	10.50	17.27	13.00	11.19	9.86	7.37	6.19	6.47	7.78	7.15	5.83	8.68	7.18	7.23	7.33	6.40
1978	3.20	2.59	3.81	13.39	11.48	18.81	23.84	18.14	37.70	21.29	16.29	21.47	24.16	16.86	22.95	13.23	10.01	8.96	8.53	11.47	8.42	6.94	10.36
1979	1.97	2.51	3.27	9.80	9.79	19.86	38.19	24.49	22.78	16.99	16.24	14.40	12.10	9.08	8.62	7.78	7.15	5.83	5.07	4.93	4.16	4.17	3.53
1980	1.72	6.70	20.57	34.17	19.41	13.52	34.77	34.80	17.27	28.69	19.00	14.40	12.10	9.08	8.62	7.78	7.15	5.83	5.14	8.17	5.14	4.96	5.47
1981	2.24	3.13	14.18	21.96	9.79	22.96	50.00	33.39	18.01	16.99	16.24	16.34	22.44	12.66	12.21	11.27	8.77	7.13	7.40	5.48	4.69	3.72	3.53
1982	0.98	1.77	3.27	5.49	6.89	13.52	23.63	18.14	18.01	36.04	35.33	29.49	24.01	15.95	14.23	11.02	9.77	8.18	6.89	5.56	3.89	3.81	3.70
1983	1.97	2.51	7.02	5.49	9.79	10.29	24.61	31.18	17.27	16.99	16.24	14.40	12.10	14.21	14.23	9.80	7.69	7.94	6.04	4.21	3.89	3.72	3.31
1984	1.74	5.66	7.07	5.49	5.66	13.52	15.44	19.09	17.27	16.99	17.53	19.92	12.10	9.24	8.62	7.78	9.81	7.56	5.44	4.21	3.89	3.72	4.77
1985	6.35	9.45	5.25	18.20	11.23	13.52	31.80	21.13	22.02	16.99	16.24	14.20	12.10	9.08	8.62	7.78	6.62	5.83	10.43	8.12	5.89	5.53	13.04
1986	6.94	4.72	13.84	7.55	9.79	12.53	22.84	46.17	20.39	16.99	16.24	14.40	12.10	9.08	8.62	7.73	6.04	5.83	5.07	4.21	3.89	3.72	5.41
1987	5.24	11.88	11.47	23.40	24.28	14.17	15.44	18.14	17.27	16.99	15.46	10.90	10.50	8.24	14.41	22.39	9.84	6.86	7.92	8.21	6.13	5.61	4.37
1988	6.79	12.70	8.26	6.37	13.83	22.46	15.44	18.14	17.27	16.99	16.24	14.40	10.35	7.88	5.97	5.81	5.42	4.36	4.23	3.90	3.66	3.31	2.91
1989	3.25	8.49	10.58	10.41	27.46	13.52	14.13	17.05	28.16	38.74	16.24	14.40	12.10	10.37	12.16	9.31	7.15	5.83	5.07	9.14	15.64	11.25	7.97
1990	5.57	11.49	17.98	10.58	15.60	13.52	15.44	25.79	17.27	16.99	21.50	27.10	20.75	17.29	12.86	15.44	11.35	8.64	7.19	6.63	4.29	4.11	3.56
1991	7.10	4.50	10.00	6.30	9.79	39.31	41.50	28.41	28.52	28.02	40.80	32.12	30.04	19.63	16.76	12.81	10.59	10.13	7.72	7.07	4.45	4.37	3.53
1992	2.81	4.30	4.61	13.60	13.79	9.70	12.74	14.43	12.86	15.73	16.24	14.22	12.10	9.08	8.62	7.78	7.15	5.83	5.07	4.21	4.37	3.72	3.53
1993	4.17	3.53	4.22	5.49	10.84	27.91	15.44	18.14	15.44	16.99	16.24	14.40	14.36	18.54	15.19	19.37	14.87	9.73	10.63	10.75	10.33	9.99	9.00
1994	3.83	10.26	14.08	6.99	21.42	18.37	15.58	18.14	17.27	16.99	15.46	14.40	12.10	9.08	8.62	7.78	7.15	5.83	5.07	4.18	3.44	3.22	2.73
1995	2.77	2.81	3.63	5.67	19.38	28.50	16.30	36.44	50.00	47.83	43.80	39.09	32.39	29.36	20.79	20.24	14.03	12.29	9.58	7.78	6.17	6.05	4.69

Appendix 3. PRC weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, calculated using data from Alberta Environment (2001). (page 2 of 6)

LBEL = Belly River at Standoff & Glenwood (Stations 05AD002 & 05AD041)

Year \ Week	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	8.52	6.18	5.31	7.49	10.40	31.75	31.59	19.01	17.82	16.74	15.94	19.64	15.65	10.97	14.13	18.33	13.54	10.49	7.10	5.31	4.48	3.84	3.84
1913	12.64	14.69	12.08	7.60	10.40	13.83	24.96	58.02	46.48	36.47	22.61	33.13	22.33	16.87	8.81	13.72	14.46	16.59	12.86	8.20	7.20	7.08	4.99
1914	4.52	13.04	12.61	16.74	14.64	21.17	20.83	19.01	17.85	17.09	17.14	14.29	14.20	12.61	9.86	8.07	6.84	6.44	7.46	10.35	5.52	4.42	3.58
1915	4.15	8.53	7.15	13.55	16.77	19.13	14.49	16.00	41.02	31.69	27.87	42.90	25.36	11.86	15.17	25.45	22.27	11.31	10.41	23.48	8.16	15.18	8.79
1916	7.79	6.54	5.35	10.80	21.01	12.46	14.49	23.05	22.40	40.48	60.00	52.96	53.79	39.58	27.52	16.51	11.23	15.29	13.04	11.37	9.45	14.29	8.02
1917	9.53	4.45	6.57	7.49	11.54	30.18	30.49	41.51	37.77	45.75	38.54	27.63	28.05	26.36	19.48	12.82	9.67	6.53	5.17	6.33	4.34	3.84	3.58
1918	6.61	5.75	8.23	21.38	17.99	13.83	13.10	15.26	17.82	44.56	18.68	14.29	12.41	9.84	8.53	7.50	6.35	5.61	7.20	4.44	4.13	4.75	4.75
1919	2.94	3.76	5.35	12.06	10.40	13.83	29.43	27.61	17.82	16.64	15.13	14.29	12.41	9.84	8.53	6.81	5.83	5.61	4.98	4.44	4.13	3.84	2.75
1920	5.65	9.34	7.15	7.49	20.02	27.00	19.97	19.01	17.82	37.20	37.89	24.39	33.04	27.46	24.11	18.17	11.75	9.87	8.39	5.14	4.59	3.84	4.93
1921	6.35	11.09	7.39	7.49	20.73	15.29	44.19	33.42	42.15	31.87	24.59	24.90	19.73	14.63	10.94	10.25	8.61	6.25	5.91	4.48	4.13	3.84	3.58
1922	2.70	4.63	6.10	14.82	10.40	24.83	33.37	31.87	44.24	29.11	27.19	18.33	14.81	20.17	12.79	7.50	6.35	7.53	4.98	4.44	4.13	4.10	3.58
1923	2.94	4.40	5.00	7.49	12.11	13.83	25.60	36.99	48.60	37.97	29.61	23.25	18.03	12.82	13.25	10.44	6.35	5.61	5.37	[illegible]	7.42	5.48	3.58
1924	3.78	3.79	3.28	7.35	13.20	28.88	15.43	19.01	28.34	42.06	34.77	19.26	23.57	14.60	8.53	7.50	8.28	12.81	11.40	[illegible]	7.17	5.73	4.04
1925	16.88	18.94	14.83	14.44	15.19	37.85	42.82	33.52	17.82	21.44	31.68	28.19	15.83	10.72	9.12	7.63	8.42	5.91	8.00	5.97	4.13	4.96	4.63
1926	2.78	16.19	9.61	14.06	10.40	8.19	8.27	5.53	7.48	8.23	14.25	13.79	10.76	9.08	6.59	5.76	4.47	5.23	4.74	4.44	4.72	12.55	10.35
1927	2.94	8.23	20.16	17.72	10.40	28.94	59.46	65.00	54.25	64.37	57.57	48.39	36.40	28.89	30.05	20.20	18.00	14.80	18.57	14.43	11.04	10.26	24.95
1928	4.17	3.81	5.29	11.91	23.14	34.51	41.37	34.15	17.82	16.74	38.21	45.40	63.23	33.29	26.30	19.89	16.20	10.53	7.57	7.03	9.22	7.20	5.76
1929	2.94	3.79	5.00	9.23	10.54	22.06	35.67	20.59	39.14	31.46	15.13	14.29	12.41	15.23	8.87	7.50	6.35	5.61	4.98	4.44	4.13	3.84	3.55
1930	10.39	13.80	21.04	27.25	21.82	15.05	27.77	25.90	19.31	17.71	15.13	14.29	12.41	9.84	9.47	7.50	6.35	5.61	4.98	4.44	4.13	3.84	4.11
1931	2.51	2.73	3.61	7.49	10.40	23.84	14.49	19.01	17.82	16.74	15.13	12.40	8.45	8.43	7.94	6.91	6.35	5.61	4.73	4.34	3.18	3.49	3.58
1932	4.18	5.22	5.10	7.49	24.68	33.51	28.78	19.01	18.42	23.49	24.84	21.28	13.99	9.84	8.53	7.50	6.35	5.61	4.98	5.48	4.13	3.80	3.56
1933	2.94	3.10	8.02	11.21	11.12	14.22	16.32	36.37	35.79	42.67	29.42	22.94	25.31	19.72	13.64	10.67	9.26	7.62	7.01	5.40	4.44	3.84	3.58
1934	13.60	19.94	32.49	25.99	32.37	30.67	17.82	25.48	44.06	27.72	15.13	14.29	12.41	9.84	8.53	7.50	6.35	5.61	4.98	4.44	4.13	3.84	3.58
1935	2.70	4.04	5.07	7.49	10.40	13.83	28.99	22.11	18.06	18.08	15.74	14.29	12.41	10.59	13.58	10.78	7.55	5.61	4.98	4.44	3.73	3.84	3.58
1936	5.48	5.86	8.68	7.49	19.09	29.05	14.41	19.01	17.23	15.80	9.77	6.98	11.29	9.46	8.53	7.50	6.23	5.21	4.98	4.44	3.32	3.84	3.53
1937	3.07	3.79	5.00	10.92	11.83	14.24	15.95	19.01	17.82	51.39	31.97	20.30	15.13	9.84	8.53	7.50	6.35	5.61	4.98	4.44	4.13	3.84	3.58
1938	5.15	13.44	9.52	15.56	11.64	23.23	34.74	37.80	27.79	20.34	27.32	21.53	22.07	16.22	12.58	8.44	6.35	5.61	4.98	4.44	4.13	3.84	3.58
1939	2.94	7.73	16.50	21.56	14.64	16.75	14.49	19.01	16.44	16.74	15.13	14.29	12.41	9.84	8.53	7.50	6.35	5.61	4.70	4.03	3.57	3.64	3.58
1940	2.94	5.39	7.65	10.37	16.69	15.93	16.34	19.01	17.82	16.74	15.13	14.29	11.14	9.33	8.14	7.50	6.35	5.45	4.51	3.94	3.67	3.78	3.58
1941	2.94	4.84	7.89	12.91	10.40	13.83	14.49	18.73	16.73	14.98	11.69	14.29	12.41	9.84	8.27	6.66	5.56	4.93	4.71	4.07	4.13	3.84	6.53
1942	4.72	11.32	13.79	7.49	19.29	13.83	26.07	19.01	41.02	16.76	15.13	31.66	23.04	13.96	8.96	7.61	8.46	7.66	5.96	5.23	4.15	4.31	5.35
1943	12.19	23.51	12.52	10.61	10.40	13.71	27.37	29.11	17.82	25.74	36.25	30.51	32.80	27.80	17.27	16.10	11.02	9.28	6.19	4.75	4.13	3.96	3.58
1944	2.94	3.51	4.40	7.49	10.40	13.83	14.49	19.01	17.82	16.74	15.13	14.29	12.41	9.22	7.68	6.98	6.01	5.06	4.98	4.44	4.13	3.84	3.58
1945	2.10	3.71	4.58	9.73	23.82	14.81	15.37	33.91	31.96	17.04	29.11	22.51	16.15	13.72	8.67	7.50	6.35	5.61	4.98	4.02	3.20	7.18	6.10
1946	2.94	10.52	22.81	17.04	19.01	26.75	23.64	31.00	26.16	18.95	22.00	14.29	14.99	14.82	10.61	7.50	6.35	5.61	4.98	4.44	4.13	3.84	3.78
1947	4.86	8.94	18.74	32.31	34.64	20.72	14.92	19.01	16.93	19.10	18.27	19.89	18.56	18.12	13.34	9.63	6.35	5.61	4.98	6.98	5.74	3.99	3.58
1948	2.94	6.90	8.64	9.74	11.33	13.83	49.04	44.86	52.39	44.21	47.15	30.94	21.71	10.54	11.08	11.71	20.99	9.41	6.49	4.99	4.65	3.84	3.58
1949	2.94	3.79	5.14	7.49	10.40	28.81	26.45	29.72	18.07	16.74	15.13	14.29	12.23	9.84	8.53	7.50	6.35	5.61	4.98	4.44	3.69	3.84	3.58
1950	6.22	10.81	6.00	6.93	10.32	25.89	16.99	24.04	33.10	35.64	45.21	33.79	39.46	28.66	21.53	19.27	15.17	11.23	8.83	7.69	6.32	5.73	5.66
1951	8.84	9.12	8.44	41.01	38.33	49.86	40.29	19.01	23.77	41.69	37.40	63.43	49.40	47.77	34.41	21.10	19.02	14.34	10.96	8.59	23.07	20.85	9.38
1952	15.23	16.94	19.38	25.48	12.45	18.07	17.39	19.01	17.82	16.74	15.13	14.29	12.75	9.98	11.34	9.14	7.64	13.06	13.54	7.35	6.05	5.07	4.17
1953	2.94	4.25	23.32	22.43	24.39	13.83	28.60	52.94	65.00	65.00	40.27	29.02	31.88	35.53	29.83	17.27	15.67	13.73	10.83	9.10	6.56	6.92	5.94
1954	8.43	7.58	5.00	7.49	15.63	41.72	51.27	31.78	25.45	27.24	24.21	34.65	36.77	36.04	30.57	20.50	15.29	11.92	9.56	11.16	12.05	8.66	6.84
1955	11.53	3.79	5.00	7.49	9.86	39.80	37.73	20.14	29.94	43.52	31.03	37.29	20.72	32.17	28.95	19.89	11.15	8.26	5.85	5.05	5.28	3.94	3.93
1956	2.94	6.81	8.96	7.49	10.40	14.44	53.95	42.37	38.01	17.62	25.49	15.69	25.96	22.71	21.27	15.80	12.43	8.16	8.54	6.13	6.67	6.48	4.20
1957	2.94	3.79	5.00	24.71	36.08	42.68	36.97	30.80	33.50	18.89	15.13	14.29	12.41	9.84	8.53	7.50	6.35	5.61	4.98	4.44	4.13	3.62	3.58
1958	6.03	5.65	5.00	7.49	28.86	29.46	33.60	24.04	22.71	26.70	19.31	18.45	12.41	11.48	8.83	10.01	9.53	6.48	4.98	4.44	5.07	3.84	3.58
1959	5.86	7.05	6.88	16.42	10.40	20.19	21.40	19.78	44.78	29.38	33.80	26.53	21.52	17.45	16.38	13.88	9.94	7.17	5.68	8.01	6.88	8.31	14.29
1960	9.91	5.94	5.00	7.49	10.40	22.39	14.49	19.01	24.20	16.74	15.13	14.29	13.44	9.84	12.51	8.74	6.75	8.84	4.98	4.44	4.13	3.84	4.55
1961	3.15	3.79	5.00	5.34	10.40	13.83	39.22	46.39	35.34	23.76	26.37	14.29	12.41	9.84	8.64	7.50	6.35	6.30	4.98	4.44	4.13	4.45	4.47
1962	4.67	10.00	16.14	7.87	10.29	13.83	16.81	19.01	17.82	18.11	10.06	14.32	12.41	9.84	8.53	7.50	6.78	6.57	4.98	4.44	4.13	4.68	5.77
1963	2.94	3.79	4.94	7.49	10.40	12.71	14.49	20.85	27.46	36.83	27.67	22.03	33.63	23.44	11.61	7.50	6.35	5.61	6.64	6.47	5.93	6.24	5.99
1964	3.37	3.74	4.41	17.96	17.26	14.55	27.32	19.01	60.63	65.00	42.46	34.87	29.10	25.54	18.77	11.38	10.46	7.29	6.80	4.93	4.13	6.14	5.96
1965	6.95	6.38	10.54	12.21	10.40	17.40	14.49	29.90	31.17	40.93	55.48	39.96	24.64	24.41	15.56	12.59	13.91	11.02	9.33	7.58	6.36	6.35	6.93
1966	9.22	7.45	5.77	7.40	25.81	13.83	14.49	36.10	47.62	26.21	18.49	15.84	17.56	16.72	15.11	11.99	10.17	7.74	5.75	11.12	8.60	5.96	5.84
1967	3.04	3.79	5.00	5.97	27.20	31.09	55.46	48.85	51.22	45.12	49.80	35.85	31.29	21.36	17.56	12.30	10.81	10.25	8.06	6.80	5.23	4.83	5.04
1968	2.94	3.79	4.62	7.49	10.40	13.83	22.28	26.11	29.41	23.69	16.40	17.87	13.57	22.10	15.00	11.03	10.22	7.85	9.47	11.84	8.07	7.80	6.78
1969	9.07	9.73	17.69	10.21	15.88	27.87	14.71	22.24	33.97	16.74	15.13	58.69	27.60	16.39	8.53	7.82	6.35	5.40	4.98	4.44	7.71	3.84	3.58
1970	3.00	3.73	3.55	7.49	22.52	25.14	38.10	30.80	46.20	55.30	54.38	26.87	12.41	9.84	8.53	7.50	6.35	5.61	4.98	4.44	4.13	3.84	4.41
1971	3.03	3.79	9.68	13.70	31.28	26.66	14.49	34.49	30.14	22.31	16.15	25.20	23.99	19.38	17.93	20.13	15.01	13.32	8.08	4.44	6.16	6.92	3.97
1972	8.74	4.88	5.00	8.13	10.40	30.50	38.90	37.46	52.96	44.21	23.02	16.55	19.41	18.90	23.35	23.38	19.46	15.51	11.96	10.65	8.88	7.56	6.99
1973	2.94	3.79	5.00	5.61	8.89	15.10	16.46	17.20	17.82	17.03	15.13	14.29	12.41	9.84	8.53	7.45	6.35	5.66	4.98	4.44	4.13	4.67	3.58
1974	3.31	4.02	11.97	18.90	23.32	13.83	13.83	23.20	26.76	39.23	51.35	39.67	26.53	20.09	21.74	19.48	14.64	12.60	11.27	6.20	6.13	5.00	5.56
1975	2.31	12.79	24.83	8.46	25.19	34.04	16.95	24.33	51.22	41.91	65.00	44.57	41.54	43.84	22.67	15.92	15.81	10.70	9.16	11.02	10.29	6.71	5.91
1976	8.69	9.60	5.36	9.51	31.71	33.82	18.77	19.01	15.36	16.74	17.36	18.74	19.64	25.97	20.80	14.33	14.15	18.24	14.20	9.79	9.13	7.26	5.90
1977	3.16	3.79	5.00	8.29	10.40	13.83	9.51	9.17	14.79	12.63	9.65	8.38	8.30	6.59	5.85	6.93	6.35	5.61	7.68	7.74	8.37	8.31	7.51
1978	3.56	3.79	5.00	14.30	18.19	21.87	25.14	19.01	34.15	21.97	16.73	20.87	26.72	18.54	29.45	14.83	10.62	8.48	8.25	13.48	9.77	7.41	12.29
1979	8.31	5.13	5.44	11.72	16.42	19.24	33.07	26.35	22.46	16.74	15.13	14.29	12.41	9.84	8.53	7.50	6.06	5.41	4.21	5.89	5.96	4.55	3.58
1980	2.94	4.48	15.72	30.20	20.30	13.83	34.13	51.18	20.24	27.86	26.80	14.29	12.41	9.84	8.53	7.50	6.35	5.61	4.98	8.35	6.27	4.76	6.13
1981	2.94	3.79	14.69	20.99	11.73	34.17	65.00	40.34	21.63	34.96	16.02	14.73	16.74	12.12	8.58	12.71	7.12	5.61	7.28	6.10	5.48	4.91	3.69
1982	7.54	3.87	5.00	7.49	9.10	13.83	23.97	19.01	20.24	33.00	36.69	34.03	29.63	19.83	13.99	13.24	10.33	6.66	7.95	6.75	6.38	5.01	4.09
1983	2.56	3.51	8.17	7.49	10.40	11.22	15.72	24.22	17.82	16.74	14.89	13.17	12.41	11.20	17.83	9.40	6.88	8.68	8.27	4.44	4.13	3.84	2.83
1984	2.33	3.79	7.82	5.60	4.44	12.61	14.49	19.01	17.82	16.74	17.48	20.10	12.41	9.84	8.53	7.50	10.29	9.68	8.35	4.44	4.13	3.54	4.28
1985	4.01	12.18	8.24	16.08	10.40	13.83	24.54	19.01	17.82	16.74	15.13	9.56	11.84	9.84	8.21	7.50	6.34	5.61	10.11	7.27	4.81	5.61	14.62
1986	5.09	3.86	10.39	7.49	10.40	12.16	16.13	45.34	17.82	16.74	15.06	12.13	12.41	9.84	8.53	7.50	6.35	5.61	4.98	4.44	4.13	4.72	6.32
1987	7.06	11.66	10.95	26.48	12.70	13.83	8.21	19.01	11.03	11.16	11.59	7.01	7.29	5.81	8.53	24.99	9.50	5.61	6.92	7.21	7.85	3.84	2.91
1988	7.46	13.19	10.88	6.18	10.40	20.02	14.49	19.01	17.82	16.34	14.49	14.29	12.41	9.79	7.28	5.99	5.81	5.06	4.71	4.09	3.79	3.02	2.58
1989	2.94	3.79	12.25	6.81	24.93	13.98	12.97	11.36	20.93	45.73	18.85	14.29	12.62	13.11	15.34	10.49	8.56	6.13	5.25	9.99	17.29	10.26	8.48
1990	4.44	8.81	15.01	9.66	15.47	13.63	14.49	32.76	17.82	17.96	19.89	29.98	22.93	16.06	13.80	13.98	13.20	10.93	9.96	9.37	8.24	3.84	3.58
1991	7.28	3.79	5.54	7.49	7.96	35.84	45.55	26.92	34.97	30.48	44.27	41.96	37.55	25.24	16.75	12.21	10.91	10.63	12.65	8.78	5.09	3.84	3.58
1992	2.94	4.54	5.13	8.52	10.40	13.31	11.33	11.38	11.19	15.47	15.13	14.29	12.79	14.96	13.10	7.50	7.72	8.73	4.98	4.44	4.99	5.27	5.18
1993	4.42	3.79	5.00	7.49	8.97	22.97	22.79	19.01	17.82	26.00	30.91	14.29	12.83	20.23	22.25	26.37	16.87	8.30	14.99	11.28	10.68	12.13	14.96
1994	3.33	7.90	16.60	10.15	18.14	24.54	19.39	19.01	17.82	16.74	15.13	14.29	12.41	9.84	8.53	7.50	6.35	5.61	4.63	3.79	4.13	3.58	2.95
1995	4.61	4.23	5.00	6.45	40.96	41.21	27.86	65.00	65.00	65.00	65.00	65.00	43.46	30.81	25.05	28.15	17.79	15.76	12.59	8.71	6.93	5.49	3.58

Appendix 3. PRC weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, calculated using data from Alberta Environment (2001). (page 3 of 6)

UWAT = Waterton River at Waterton Park (Station 05AD003)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	6.01	8.73	9.77	10.92	19.07	41.38	46.46	36.84	40.91	38.57	33.31	27.89	23.56	27.82	23.05	29.91	21.59	15.89	10.80	8.39	6.24	6.36	6.07
1913	3.24	10.60	18.54	11.75	17.57	27.47	36.54	117.00	116.45	92.12	47.57	56.91	37.65	23.48	13.74	15.77	16.48	19.07	19.30	13.06	10.30	8.04	6.15
1914	7.94	20.14	25.15	34.84	38.91	58.10	51.96	36.84	45.52	36.23	39.23	26.83	24.43	21.25	17.17	9.79	7.90	7.16	8.67	12.50	11.51	7.44	5.91
1915	7.70	20.63	20.47	28.10	39.47	28.27	32.44	36.51	40.91	36.23	33.31	29.63	25.19	16.80	18.26	17.22	18.46	13.37	11.64	10.51	8.27	12.12	10.67
1916	7.53	9.82	9.79	25.68	41.31	28.27	31.39	34.79	40.91	76.52	117.00	111.50	104.00	84.01	50.10	35.35	23.49	20.84	14.88	16.51	14.93	16.82	18.27
1917	2.98	3.22	4.40	5.03	19.07	61.55	67.52	74.50	62.64	75.12	87.94	65.57	62.80	54.44	39.02	21.20	11.34	8.57	6.48	5.36	4.69	4.33	4.19
1918	8.29	15.32	15.03	16.25	24.67	31.48	30.17	28.43	40.91	106.90	60.05	28.76	20.39	13.68	11.63	9.79	7.88	8.44	7.87	6.16	6.57	6.51	7.89
1919	4.85	5.36	11.85	31.60	19.07	25.87	76.19	75.61	40.91	36.23	33.31	26.83	20.39	13.68	11.63	8.71	7.40	6.69	5.82	4.79	4.22	4.30	3.79
1920	3.24	4.34	6.32	10.27	19.07	28.27	36.85	36.84	40.91	73.75	105.80	63.19	74.16	53.10	35.16	21.67	12.84	10.22	10.84	5.62	5.47	4.39	5.09
1921	10.11	19.14	12.79	10.92	34.71	39.54	100.60	69.63	99.10	98.22	63.52	81.03	42.31	30.56	20.73	14.91	11.48	9.03	8.30	6.74	5.39	4.45	5.13
1922	2.98	3.08	6.33	19.64	19.07	49.86	72.16	78.24	115.90	81.44	65.81	32.27	23.00	26.07	13.31	9.79	7.88	6.69	5.82	4.85	4.22	4.33	4.19
1923	3.24	8.25	10.19	12.09	24.97	37.13	62.64	105.90	98.13	84.83	47.17	39.65	27.21	17.50	13.40	10.27	7.97	6.92	5.82	11.48	9.02	6.88	5.53
1924	3.24	4.34	6.33	10.92	20.10	84.88	64.79	36.84	54.88	101.15	70.51	34.70	35.39	18.16	11.63	9.79	7.88	11.23	10.99	10.44	7.56	6.45	5.04
1925	18.14	22.10	16.36	16.56	32.78	61.16	93.27	67.32	40.91	54.00	69.73	57.27	29.57	16.33	11.87	9.79	7.88	6.69	7.49	8.86	7.94	7.16	7.47
1926	8.21	31.03	29.64	38.57	23.23	26.13	25.11	20.09	18.47	17.90	20.07	20.09	17.31	12.98	10.90	9.42	7.76	6.69	5.35	4.75	4.27	13.64	15.74
1927	3.24	4.34	13.60	34.79	19.07	52.01	58.50	65.60	105.30	117.00	117.00	99.11	65.40	59.09	55.35	31.37	19.51	16.67	19.17	17.17	12.63	13.36	23.60
1928	5.20	4.34	6.33	18.57	49.60	80.93	109.32	82.32	40.91	39.26	74.11	76.59	85.63	67.74	38.41	15.27	15.79	10.36	7.09	6.36	8.59	7.93	7.35
1929	3.24	4.34	6.33	12.94	19.07	32.00	85.78	56.10	68.91	62.37	33.31	26.83	20.39	19.00	12.72	9.79	7.88	6.69	5.82	4.85	4.22	4.31	4.12
1930	21.02	23.27	39.96	53.19	43.89	28.27	56.21	43.51	48.90	39.77	33.31	26.83	20.48	17.09	15.30	10.86	7.88	6.69	5.82	4.85	4.22	4.33	4.19
1931	3.24	4.34	6.33	23.95	36.28	55.99	32.44	36.84	40.91	34.00	30.38	22.32	12.83	11.99	10.95	9.20	11.03	6.69	5.82	4.85	4.11	4.33	4.19
1932	5.97	7.27	8.53	10.92	44.89	65.18	66.44	36.84	40.91	48.71	52.82	47.33	23.78	15.26	11.90	9.79	8.14	6.69	5.98	7.51	7.16	5.67	4.19
1933	3.24	4.34	9.40	16.95	19.68	28.27	32.44	86.75	89.20	112.05	97.92	73.26	55.06	38.46	25.65	15.91	12.26	10.00	9.69	8.88	8.40	5.21	4.55
1934	14.77	33.44	63.13	54.34	80.89	69.12	44.37	54.50	93.49	67.76	33.31	26.83	20.39	13.68	11.63	9.79	8.61	6.69	5.82	4.85	4.22	4.33	4.19
1935	3.24	6.51	7.22	10.92	19.07	28.27	66.17	53.93	40.91	40.61	33.50	27.94	20.39	16.33	20.47	15.11	11.99	8.39	6.85	4.85	4.22	4.51	4.19
1936	5.43	12.80	19.49	18.27	46.33	67.01	32.44	52.07	40.91	36.23	33.31	26.83	17.05	13.56	11.16	9.79	7.86	6.45	5.82	4.85	4.15	4.33	3.92
1937	3.24	4.34	6.33	15.28	21.60	28.27	32.44	36.84	40.91	117.00	81.47	44.36	24.51	14.96	11.75	9.79	7.88	6.69	5.82	4.85	4.22	4.33	4.19
1938	3.84	21.81	15.37	26.92	20.44	45.26	73.06	103.15	62.64	42.79	63.03	50.22	30.96	21.63	17.11	13.26	7.88	6.69	5.82	4.85	4.22	4.33	4.27
1939	4.14	8.63	28.54	40.17	31.03	38.01	32.44	36.84	33.29	33.18	33.31	26.83	20.39	13.68	11.63	9.79	7.88	6.69	5.82	4.85	4.22	4.33	4.19
1940	3.24	6.19	9.02	13.18	24.38	33.67	32.75	36.84	40.91	36.23	33.31	25.93	15.32	12.24	10.29	9.79	7.88	6.69	5.25	4.42	4.03	4.33	4.19
1941	4.44	5.81	8.55	19.84	19.07	28.27	27.63	35.58	33.24	28.01	21.22	26.83	20.39	13.68	11.00	8.47	6.71	5.72	5.32	4.63	4.22	4.33	7.56
1942	6.78	13.86	23.77	11.52	30.08	28.27	47.40	36.84	92.84	38.77	33.31	52.11	34.11	22.00	17.34	14.46	12.53	11.83	9.44	7.27	5.90	5.07	5.41
1943	13.26	43.24	30.56	21.36	19.07	24.26	53.07	72.85	40.91	59.08	101.81	71.75	60.54	50.31	26.13	28.61	19.08	13.15	9.74	5.78	4.60	5.08	4.19
1944	3.24	3.78	3.81	10.92	17.12	28.27	32.44	36.84	36.79	34.88	33.31	26.83	20.39	13.12	9.44	8.56	7.38	6.02	6.65	5.84	4.45	4.84	4.19
1945	2.81	3.51	3.53	10.92	42.29	32.08	32.44	74.98	75.97	37.39	63.79	54.88	23.21	19.33	13.01	9.85	7.88	6.69	5.82	4.85	3.80	7.22	6.99
1946	6.76	15.07	32.60	31.71	37.09	55.47	44.21	68.11	55.13	40.54	39.03	27.70	22.11	21.74	16.40	10.08	7.88	6.69	5.82	4.85	4.52	5.42	5.42
1947	5.91	16.23	31.89	62.51	75.03	49.10	32.44	36.84	40.91	40.12	36.26	39.04	27.21	25.24	18.74	14.14	10.73	7.99	5.82	9.24	7.44	5.26	4.31
1948	2.89	5.60	13.14	14.80	19.07	28.27	117.00	117.00	117.00	111.40	109.05	52.61	27.64	14.06	11.63	10.99	20.36	15.69	10.91	8.55	4.56	4.33	4.19
1949	3.24	7.27	13.17	17.29	29.48	79.90	58.98	67.81	53.55	36.23	32.31	26.83	20.39	13.68	11.63	9.79	11.00	7.08	5.82	4.85	4.22	4.33	4.19
1950	3.24	5.62	7.53	9.97	14.42	41.97	34.68	52.63	65.69	94.83	117.00	93.77	93.15	55.03	36.12	28.52	21.06	15.61	12.11	8.69	7.16	5.81	4.89
1951	10.34	11.75	12.05	36.63	68.90	80.19	87.26	36.84	39.09	70.05	71.33	84.46	79.96	66.04	62.28	37.20	25.46	17.17	12.49	9.95	22.48	25.61	18.95
1952	4.07	16.80	34.78	51.31	24.86	43.84	57.73	36.84	40.91	36.23	33.31	26.83	22.22	17.18	14.97	14.02	10.87	12.94	13.91	9.00	6.05	4.91	4.59
1953	3.44	4.34	14.40	20.63	39.94	28.27	48.43	84.54	117.00	117.00	69.17	42.76	58.54	62.34	42.86	22.57	14.90	12.64	10.32	7.03	6.11	6.14	5.27
1954	3.38	5.88	6.47	8.48	19.07	70.86	112.40	60.87	52.33	60.38	49.84	83.66	89.16	74.05	61.84	31.96	22.32	16.33	13.13	12.48	20.27	15.11	8.91
1955	3.24	4.34	5.15	6.17	11.69	26.94	32.44	36.84	57.11	101.15	79.63	89.44	38.24	54.33	48.83	27.63	17.16	12.11	7.94	5.23	4.22	4.33	4.19
1956	3.24	9.59	20.47	10.92	16.80	28.27	117.00	109.20	91.96	56.97	55.78	34.87	36.76	34.72	32.02	21.71	14.82	10.26	8.93	6.56	6.86	5.30	4.71
1957	2.68	2.74	6.33	39.81	88.21	95.04	81.37	74.02	84.69	45.04	33.31	26.83	20.39	13.68	11.63	9.79	7.88	6.69	5.63	4.64	4.09	3.29	2.92
1958	4.03	7.65	7.88	11.22	53.31	79.70	90.93	77.06	54.46	52.47	33.31	26.83	20.39	14.01	11.03	9.93	7.88	6.69	5.82	4.85	4.22	4.05	3.78
1959	9.93	11.19	11.60	25.94	21.17	30.83	35.39	36.84	101.95	70.97	82.57	61.87	41.04	33.85	34.77	25.97	14.40	9.26	6.35	5.57	7.27	10.02	21.07
1960	20.46	14.76	8.56	10.92	19.07	54.93	30.51	36.84	80.63	59.64	43.23	34.13	35.89	26.76	21.52	14.68	11.24	11.55	7.61	4.85	4.22	4.33	4.21
1961	6.32	5.14	6.33	10.92	19.07	28.27	89.99	117.00	117.00	68.51	64.90	30.32	20.39	14.09	11.63	9.79	7.88	6.69	5.82	4.85	4.22	4.33	4.19
1962	6.78	19.53	36.08	17.90	19.07	28.27	46.80	47.71	40.91	51.32	49.26	32.21	20.39	14.48	11.63	9.79	10.07	7.95	5.82	4.85	4.22	4.33	5.38
1963	3.92	5.93	6.53	12.84	19.07	28.27	36.50	56.69	70.93	96.08	57.82	40.39	54.57	32.27	17.51	11.31	7.88	6.69	6.15	4.85	4.22	4.33	4.19
1964	3.24	4.34	6.33	12.04	22.38	30.09	62.13	37.30	117.00	117.00	77.22	75.60	54.37	39.12	25.10	15.56	12.39	9.18	6.63	4.85	4.22	6.11	6.23
1965	3.24	5.61	12.05	28.43	19.29	42.36	32.44	55.42	67.48	95.67	112.60	66.62	50.13	51.02	30.67	18.77	15.16	13.79	11.08	8.66	7.22	6.59	8.00
1966	14.23	11.62	8.31	10.92	50.10	28.27	32.44	95.94	77.83	61.19	40.97	31.21	31.51	26.43	19.88	13.89	9.00	8.24	5.82	10.22	9.40	7.30	5.67
1967	3.24	4.34	6.33	7.64	14.28	28.27	95.09	83.11	86.69	83.83	108.70	92.47	66.72	40.34	26.64	18.12	13.19	11.02	8.44	5.88	4.39	4.33	4.19
1968	4.18	4.34	6.23	10.92	19.07	28.27	55.43	54.81	74.62	62.62	44.05	37.69	30.09	29.59	19.57	14.20	11.99	9.31	9.75	11.60	9.76	8.39	8.20
1969	11.70	18.47	27.41	20.27	33.97	60.44	40.33	58.80	88.24	39.23	33.31	74.55	37.99	22.64	14.18	12.49	7.88	6.69	5.82	4.85	4.22	3.98	3.58
1970	3.09	3.75	4.28	7.38	27.38	41.21	80.07	73.24	113.40	115.50	97.92	51.06	23.45	17.38	12.46	9.79	7.88	6.69	5.82	4.85	4.22	4.33	4.19
1971	3.24	4.49	21.36	33.47	72.11	63.07	35.55	99.08	84.59	61.86	46.52	58.73	39.51	35.80	40.99	36.67	25.26	18.43	12.74	8.48	5.81	5.58	4.45
1972	12.53	7.89	6.50	11.24	19.07	60.00	83.54	101.10	117.00	103.70	61.34	42.98	45.88	40.06	44.76	43.09	31.52	23.88	15.81	15.26	11.90	9.66	8.73
1973	3.24	4.34	6.33	10.92	19.07	53.78	60.72	36.84	43.75	43.18	33.31	28.91	20.39	13.68	11.63	9.79	7.88	6.69	5.82	4.85	4.22	4.33	4.19
1974	3.87	5.73	18.39	29.57	46.96	28.27	30.33	50.09	59.07	113.70	117.00	114.75	64.67	52.31	45.96	32.23	25.20	17.91	13.64	10.39	7.74	6.63	5.81
1975	2.15	2.37	3.82	6.01	19.07	58.66	32.44	36.84	95.14	88.72	117.00	95.17	98.94	92.89	40.17	21.74	23.30	15.23	9.84	10.40	14.74	11.14	8.51
1976	8.94	17.69	9.36	11.88	56.63	76.41	47.13	45.64	38.63	36.23	38.17	33.02	45.34	42.67	34.84	23.24	17.69	21.67	22.29	19.06	13.01	9.20	6.70
1977	4.25	5.12	9.51	27.52	23.79	28.27	26.01	25.93	40.91	33.60	24.21	17.30	11.43	8.62	7.76	7.97	7.88	6.69	8.08	9.09	9.00	10.62	9.22
1978	6.85	5.95	6.66	25.57	25.75	42.27	54.44	36.84	85.90	57.52	36.99	49.56	48.26	26.93	24.43	19.60	12.72	8.99	6.81	10.77	11.09	8.78	11.37
1979	3.24	4.34	6.33	12.77	19.07	28.27	65.36	56.13	55.36	40.29	33.31	26.83	20.39	14.30	11.63	9.79	7.88	6.56	5.53	4.85	4.22	4.33	4.19
1980	3.01	5.41	37.63	69.84	49.84	29.07	65.89	94.28	40.91	54.67	40.50	28.83	19.41	13.68	11.63	9.79	7.88	6.69	5.82	5.86	6.70	6.30	5.65
1981	3.63	4.43	21.85	41.88	26.91	34.51	117.00	83.76	50.22	36.23	34.22	35.91	37.75	25.13	21.14	18.83	13.57	9.70	6.91	4.98	4.22	4.33	4.19
1982	3.24	4.21	6.33	10.92	15.11	28.27	50.05	36.84	42.59	77.19	85.71	80.19	55.79	31.35	22.24	17.51	14.71	11.33	9.32	6.20	5.19	4.39	4.19
1983	3.24	4.34	10.63	10.92	19.07	20.21	33.77	80.36	40.91	37.35	33.31	26.83	20.39	19.77	22.64	15.77	12.13	9.69	7.28	4.85	4.22	4.33	4.19
1984	3.24	6.33	14.55	10.92	12.54	26.63	32.44	36.84	40.91	36.23	44.37	45.59	28.33	17.40	12.83	9.79	10.73	7.34	5.82	4.85	4.22	3.83	4.19
1985	6.45	20.53	11.95	38.20	28.63	28.27	69.14	54.00	42.01	36.71	33.31	26.83	20.39	13.68	11.63	9.04	7.07	6.43	9.94	11.37	7.39	6.73	12.11
1986	14.17	9.40	23.26	16.03	19.07	25.81	43.10	112.10	64.98	36.23	33.31	25.49	20.39	13.68	11.63	9.79	7.72	6.69	5.59	4.42	4.13	4.33	4.60
1987	9.45	17.20	22.61	68.34	66.08	58.64	32.44	36.85	40.26	36.23	27.74	18.38	14.83	12.23	13.55	39.00	17.39	9.94	11.46	12.05	10.76	7.72	5.71
1988	7.41	17.71	19.66	13.44	19.07	47.19	32.44	36.84	40.91	36.23	33.31	25.50	18.37	13.26	9.68	7.38	6.36	5.56	4.78	3.99	3.50	2.95	2.59
1989	3.94	9.77	24.09	23.83	60.45	32.39	32.44	33.17	60.38	79.60	34.45	26.83	20.41	16.41	17.90	13.82	8.38	6.69	5.82	7.61	15.61	20.04	13.17
1990	10.88	12.80	32.15	21.11	35.80	28.27	32.44	56.17	40.91	38.23	51.54	76.27	48.99	33.50	21.69	24.15	23.26	12.46	9.64	8.59	5.87	4.33	4.19
1991	11.94	8.47	18.04	14.64	19.07	62.39	98.12	56.63	72.80	64.74	84.40	91.54	72.57	45.87	35.44	25.29	19.87	15.99	12.63	9.12	6.95	5.10	4.82
1992	5.99	6.13	8.66	25.51	37.98	28.27	29.76	34.84	32.56	31.33	32.80	24.40	20.39	14.18	11.63	9.79	7.88	6.69	5.82	4.85	4.93	5.50	4.84
1993	4.81	4.97	6.33	10.92	19.07	73.45	60.46	36.84	40.91	36.17	33.31	26.83	20.39	28.79	33.73	26.97	23.97	13.91	11.84	12.34	9.89	10.35	8.62
1994	4.35	8.94	24.09	13.38	39.74	50.91	34.30	36.84	40.91	36.23	29.50	26.83	20.39	13.68	11.63	9.79	7.88	6.52	5.36	4.44	3.68	3.19	2.66
1995	4.67	4.49	6.33	10.92	23.38	48.57	37.23	81.26	117.00	91.76	75.61	68.07	52.55	37.58	23.83	26.43	18.09	14.56	12.29	9.29	7.26	5.84	5.09

Appendix 3. PRC weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, calculated using data from Alberta Environment (2001). (page 4 of 6)

LWAT = Waterton River at Standoff & Glenwood (Stations 05AD008 & 05AD028)

Week																							
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	16.73	15.50	14.74	17.40	27.29	60.24	46.03	51.67	52.14	47.55	40.97	47.72	27.57	28.49	21.07	40.19	31.00	18.40	15.00	12.51	10.18	10.26	9.92
1913	10.60	27.94	27.59	18.15	27.29	36.04	47.72	148.35	132.10	110.60	73.41	84.14	52.10	37.40	18.69	22.76	26.28	28.83	25.31	16.82	14.37	11.75	9.57
1914	7.70	23.10	26.16	39.99	44.36	42.99	47.98	51.67	52.14	46.84	44.41	34.64	27.48	34.53	20.13	14.10	17.09	12.29	13.06	15.25	10.69	8.65	7.30
1915	9.00	21.35	17.89	32.61	47.39	42.07	45.16	51.66	74.23	48.28	48.47	65.99	37.15	27.25	25.13	31.79	31.39	23.72	17.52	18.89	14.08	20.38	14.68
1916	17.79	17.35	14.14	25.01	49.36	36.04	46.03	51.67	57.70	94.63	175.00	133.70	123.70	98.87	62.67	41.74	19.92	21.60	17.33	20.49	17.83	23.92	17.52
1917	10.93	7.71	9.81	16.91	27.29	76.49	80.35	103.20	69.69	100.17	119.90	78.32	68.85	54.93	32.73	21.27	14.41	11.30	8.68	6.61	6.09	5.91	5.35
1918	16.51	21.15	18.04	38.24	61.39	36.58	35.69	33.99	52.14	95.43	58.71	34.00	26.11	18.31	14.42	12.57	10.17	8.59	10.00	6.09	6.71	11.28	13.21
1919	5.94	7.71	9.81	31.54	27.29	30.73	79.60	76.12	52.14	41.44	40.97	34.00	28.82	18.31	9.47	8.87	10.17	8.59	7.55	6.21	5.52	5.52	5.35
1920	6.72	9.81	12.70	16.96	42.47	56.94	46.03	48.66	52.14	86.31	93.16	61.09	71.95	51.31	37.12	22.57	15.00	10.43	11.64	8.82	6.46	5.53	5.35
1921	13.74	26.02	17.61	16.96	48.17	39.76	97.17	97.27	102.20	94.40	66.01	60.03	54.14	38.10	23.85	17.34	15.36	10.86	9.36	6.21	5.52	5.53	5.86
1922	5.94	12.66	10.84	34.37	27.29	61.76	93.70	102.25	122.75	89.40	67.47	39.07	26.85	35.71	18.02	12.57	10.17	8.59	7.69	6.21	5.52	5.53	5.35
1923	5.94	10.08	12.54	16.96	30.07	41.06	73.71	175.00	175.00	125.90	89.16	74.69	37.63	24.39	23.26	16.93	11.11	10.63	8.66	23.86	17.83	10.58	8.21
1924	8.92	7.71	9.81	16.96	30.11	77.04	53.13	51.67	88.66	131.30	86.90	42.06	37.68	28.10	18.80	13.80	11.67	24.04	19.70	16.31	10.06	7.01	6.00
1925	36.08	45.36	39.80	30.30	37.84	94.84	130.53	84.95	52.14	69.88	80.24	55.57	38.20	22.44	16.24	12.95	10.17	8.59	9.21	10.85	9.05	7.83	7.82
1926	8.21	32.27	36.83	43.09	27.29	32.63	29.39	22.04	18.86	19.91	39.09	34.00	26.11	15.26	12.07	9.82	7.29	6.90	6.97	5.70	5.52	18.53	30.66
1927	8.36	18.14	39.00	51.06	28.37	66.47	127.00	175.00	165.30	157.90	123.65	125.67	94.60	76.99	80.39	46.06	31.24	19.91	24.89	28.26	18.03	14.15	72.68
1928	10.21	9.89	14.22	24.34	55.69	102.20	141.30	89.87	52.14	46.09	128.55	146.95	160.85	64.06	48.63	28.39	21.20	16.17	11.83	8.68	21.33	14.70	10.19
1929	5.94	7.71	14.27	23.02	32.87	45.17	100.20	77.80	101.03	85.34	40.97	34.00	27.08	24.27	16.33	12.57	10.17	8.59	7.55	6.03	5.29	5.53	5.35
1930	25.47	29.54	51.63	60.86	58.34	37.45	55.21	52.07	52.42	47.40	40.97	34.00	26.11	18.31	16.00	13.07	10.17	8.59	7.55	6.21	5.52	5.53	6.57
1931	5.51	6.32	7.87	18.85	27.61	62.94	46.03	51.67	52.14	46.09	40.09	31.41	17.07	15.77	14.30	11.92	12.97	9.22	7.55	6.21	5.52	5.53	5.41
1932	8.52	11.38	17.33	16.96	50.27	82.91	95.18	51.67	52.14	52.60	72.16	58.92	31.21	20.43	15.50	12.84	10.72	9.78	8.37	8.57	7.40	5.53	5.35
1933	5.94	7.71	13.42	28.80	30.99	36.31	46.03	94.31	115.30	125.90	113.10	71.37	55.54	41.94	30.09	20.30	17.39	13.94	12.41	11.03	8.81	6.61	5.46
1934	31.81	51.10	77.52	79.36	111.60	93.61	66.39	71.73	103.00	99.80	42.91	34.96	26.11	18.43	14.42	12.57	10.80	9.72	7.55	6.21	5.52	5.63	5.35
1935	5.94	10.04	9.81	16.96	27.29	32.89	64.17	51.67	52.14	47.50	41.65	34.00	26.11	21.78	25.03	17.58	13.39	8.59	7.55	6.21	5.52	5.53	5.35
1936	17.21	8.59	22.32	23.30	53.80	97.99	46.03	62.60	57.24	46.09	35.77	26.67	22.96	17.47	14.42	12.57	6.06	5.56	5.26	6.21	5.10	5.53	5.35
1937	5.94	7.71	9.56	16.96	27.29	36.04	46.03	75.33	58.97	175.00	101.10	38.01	26.11	18.31	14.42	12.57	10.17	8.59	7.55	6.21	5.52	5.53	5.22
1938	8.29	17.83	24.40	42.08	28.83	46.99	102.10	112.48	94.69	58.67	75.33	64.31	41.30	23.21	15.48	12.57	10.17	8.59	7.55	6.21	5.52	5.53	5.37
1939	5.94	7.71	25.30	46.75	46.33	38.88	46.03	51.67	39.93	45.79	40.97	34.00	26.11	18.31	14.42	10.04	7.94	7.47	5.78	4.47	3.91	4.07	4.32
1940	5.94	7.71	15.43	18.58	27.29	39.43	46.03	51.67	52.14	46.09	40.97	30.81	22.83	16.30	12.31	12.57	14.89	8.59	6.90	6.00	5.01	5.53	5.35
1941	5.94	7.73	11.62	30.99	27.29	36.04	46.03	51.67	47.63	37.19	32.19	34.00	26.11	18.31	14.42	12.57	10.17	7.77	6.95	6.21	5.52	5.53	8.10
1942	9.23	20.04	35.82	21.71	46.49	64.44	90.05	68.00	175.00	58.11	41.13	110.00	80.20	45.74	28.89	23.87	34.18	24.66	16.97	12.90	11.71	12.71	9.98
1943	28.72	55.98	52.19	38.74	28.54	36.04	56.57	110.00	52.14	71.90	94.77	68.29	84.27	65.96	47.58	37.32	29.63	17.24	10.27	6.30	5.86	6.37	6.09
1944	5.79	5.33	5.25	9.40	17.17	36.04	46.03	46.77	46.69	45.57	40.97	34.00	26.11	18.31	13.61	9.46	7.63	6.23	7.55	5.46	5.52	5.53	5.35
1945	4.44	5.89	7.14	16.96	54.16	46.72	46.03	110.00	141.35	83.28	77.17	79.44	36.08	23.47	15.85	12.57	10.17	8.59	7.55	6.21	5.48	4.77	5.77
1946	5.94	10.79	23.74	35.13	46.77	55.86	73.76	88.95	87.56	55.47	49.60	36.88	26.99	25.83	17.18	12.57	10.17	8.59	7.55	6.21	5.52	9.54	10.19
1947	12.99	19.19	34.23	65.77	99.04	68.08	46.03	51.67	54.96	71.90	45.06	40.37	35.49	32.20	18.68	13.24	10.17	8.59	7.55	8.40	11.49	7.52	6.22
1948	4.95	39.39	29.39	26.32	35.33	74.23	165.40	166.90	151.10	175.00	175.00	96.05	50.27	23.73	24.25	19.49	38.60	27.18	16.34	12.29	9.26	7.03	5.89
1949	6.98	8.23	11.64	16.96	27.29	87.83	90.36	94.31	56.91	46.09	40.97	34.00	26.11	20.22	25.97	18.61	17.86	14.89	12.24	9.37	8.50	7.43	7.64
1950	18.58	24.91	18.62	16.96	27.29	68.36	46.54	60.30	78.53	117.90	150.70	99.05	102.30	75.39	48.09	32.90	30.10	21.97	15.52	13.54	9.17	6.91	6.63
1951	27.57	29.29	32.62	89.93	103.00	135.55	115.15	66.76	65.22	119.25	115.80	175.00	128.40	126.70	98.02	57.89	52.19	45.38	40.07	35.70	57.26	56.63	40.47
1952	21.94	36.08	46.23	59.36	38.17	65.43	78.43	51.67	52.14	46.63	40.97	34.00	27.70	24.35	30.31	24.97	15.83	25.21	27.24	14.16	10.43	9.25	7.06
1953	5.94	8.04	45.90	56.47	62.61	40.70	69.93	139.00	175.00	141.87	75.67	52.55	59.89	70.40	50.88	39.14	24.91	19.64	15.18	9.57	7.61	7.27	6.49
1954	9.48	15.09	10.42	16.90	40.30	108.10	156.70	86.36	76.79	63.74	83.80	91.79	114.00	79.80	78.10	42.14	24.17	17.54	14.03	13.76	27.52	18.73	13.21
1955	17.96	7.71	9.81	12.36	21.39	69.77	81.72	51.67	72.33	128.60	104.65	96.48	48.64	64.82	53.43	36.47	20.11	14.34	10.16	6.21	5.52	5.53	4.83
1956	12.28	13.16	31.52	16.96	27.29	43.38	159.50	137.90	103.80	72.50	70.24	46.24	66.11	50.37	39.28	21.36	18.91	13.53	9.84	8.21	7.69	5.53	5.35
1957	5.94	7.60	9.81	45.34	82.24	128.70	119.20	79.47	96.81	67.67	40.97	34.00	26.11	18.31	14.42	12.57	10.17	8.59	7.55	6.21	5.52	5.53	5.35
1958	21.40	15.33	11.45	16.96	80.80	117.40	109.75	98.99	92.78	90.60	54.54	35.36	26.11	22.55	15.67	13.79	10.34	8.59	7.55	6.21	5.52	5.53	5.35
1959	15.04	23.83	19.42	44.43	34.59	62.61	81.24	51.67	121.60	94.40	92.13	86.06	62.79	41.06	44.39	30.17	18.01	10.78	8.84	7.53	7.04	8.31	16.91
1960	22.18	21.56	12.24	16.96	34.87	71.21	46.03	51.67	88.14	54.41	43.90	34.00	39.38	35.12	23.26	16.55	14.19	17.70	9.65	6.21	5.52	5.53	5.35
1961	6.08	7.71	9.81	16.96	27.29	40.76	131.50	156.30	150.40	110.60	76.76	39.02	26.11	18.31	14.42	12.57	10.17	8.59	7.55	6.21	5.52	5.53	5.35
1962	10.58	23.24	50.34	22.74	25.80	36.04	47.91	51.67	52.14	70.73	56.68	37.84	26.11	18.31	14.54	12.57	10.17	9.53	7.55	6.21	5.52	5.96	5.81
1963	5.39	7.75	9.41	16.96	27.29	36.04	46.03	61.77	68.79	113.20	68.32	62.40	76.96	38.64	18.40	12.57	10.17	8.59	7.55	6.21	5.52	5.45	5.35
1964	5.94	6.80	7.05	48.63	51.67	40.50	90.05	55.45	175.00	175.00	118.00	93.24	73.01	74.77	34.94	18.28	10.62	8.59	7.55	6.21	5.52	6.72	7.56
1965	10.08	10.95	11.41	16.96	11.02	6.67	24.93	51.67	85.32	109.10	163.60	129.13	85.77	67.92	49.28	35.18	19.15	20.41	13.74	10.25	8.34	7.74	8.77
1966	20.60	16.08	11.97	16.96	68.86	36.04	46.03	110.70	137.20	92.97	64.07	51.56	53.47	44.09	30.37	20.78	13.88	11.59	7.55	14.93	13.49	10.67	7.96
1967	6.16	7.71	9.81	15.51	57.22	81.89	145.20	124.90	148.70	139.80	140.90	114.10	87.72	53.25	30.77	19.93	13.39	10.19	9.45	7.28	5.55	5.53	5.35
1968	5.94	7.71	9.81	14.14	27.29	36.04	67.01	73.77	101.03	91.13	62.85	49.67	38.29	39.82	18.73	16.03	11.25	10.25	12.09	14.71	11.49	11.34	10.61
1969	27.47	24.09	35.47	52.87	59.61	111.20	75.47	82.73	113.20	53.86	40.97	152.60	63.89	27.69	17.04	13.18	10.17	8.59	7.55	6.08	5.33	5.53	4.20
1970	5.94	6.58	6.90	16.96	45.91	61.10	95.50	83.23	109.40	151.15	120.70	58.21	26.11	18.52	14.76	12.57	10.17	10.37	7.55	6.21	5.29	5.01	5.35
1971	5.94	7.71	21.54	35.68	88.35	79.69	47.93	132.00	97.66	73.07	43.81	67.67	42.52	41.59	40.57	39.96	29.24	22.73	14.19	9.70	6.60	6.23	5.35
1972	20.09	11.95	12.53	19.24	27.29	60.38	107.90	124.90	157.20	135.90	65.59	42.84	42.28	45.96	64.56	53.54	44.66	31.82	21.67	19.72	14.38	12.47	11.40
1973	5.94	7.71	10.03	16.96	25.41	58.93	60.62	51.67	52.14	46.74	40.97	34.00	26.11	18.31	14.42	12.57	10.17	8.59	7.55	6.08	5.52	5.53	4.76
1974	6.38	8.52	28.09	47.95	58.96	36.04	46.03	55.61	73.94	122.96	155.16	105.70	64.62	48.99	50.63	34.56	22.25	15.76	20.36	11.88	7.72	6.15	6.47
1975	2.58	7.71	29.78	16.96	65.37	109.85	58.39	70.36	125.70	100.70	175.00	118.50	103.39	109.40	51.65	41.27	25.83	12.17	12.84	13.81	18.70	14.97	11.24
1976	15.77	28.63	18.32	21.30	81.67	90.89	46.93	51.67	43.77	46.09	46.24	38.59	44.34	47.49	37.54	26.53	18.63	37.73	30.25	21.03	14.63	9.91	8.33
1977	5.94	7.71	9.81	27.93	27.29	36.04	30.79	29.77	40.80	41.49	28.77	20.57	15.66	10.90	8.80	8.41	9.23	8.59	10.60	12.77	12.14	12.93	14.23
1978	8.40	8.23	9.81	33.49	36.14	53.92	59.71	51.67	96.18	56.09	40.97	48.89	55.24	36.31	41.44	27.25	17.56	12.42	7.55	11.24	17.96	10.84	13.69
1979	10.34	10.11	11.73	24.95	29.61	38.30	80.93	71.13	56.39	46.09	40.97	34.00	26.11	18.31	14.42	12.57	10.17	8.33	6.91	6.22	7.66	5.76	5.35
1980	4.58	7.71	41.51	85.28	60.04	36.04	94.53	127.21	52.20	66.47	60.16	34.00	23.13	18.31	14.42	12.57	10.17	8.59	7.90	10.19	9.81	9.66	7.76
1981	6.57	7.71	20.65	58.52	40.74	85.54	175.00	107.60	52.14	56.11	42.80	40.91	41.58	31.27	28.02	31.36	19.67	12.85	11.51	8.36	6.36	6.89	5.35
1982	6.00	7.55	9.41	16.70	20.87	33.53	52.02	51.67	52.14	80.93	103.50	82.14	58.83	37.50	28.78	20.19	16.55	12.48	9.14	6.32	5.86	5.53	5.35
1983	5.94	6.16	10.80	16.96	24.27	26.36	46.03	83.47	52.14	46.09	40.97	34.00	26.11	21.35	30.32	21.21	16.34	11.09	10.20	7.10	5.52	5.53	5.08
1984	4.26	7.71	16.67	16.96	17.26	30.57	46.03	51.67	52.14	46.09	51.36	53.79	33.21	23.10	16.72	13.20	12.97	11.66	7.65	6.21	5.52	5.52	5.35
1985	5.94	18.39	13.85	31.84	43.78	36.04	86.84	55.73	52.14	46.09	40.97	34.00	26.11	18.31	14.42	12.57	8.35	6.83	13.50	17.74	13.12	8.74	22.23
1986	16.55	11.69	33.27	20.56	27.29	38.04	46.03	138.20	80.64	46.09	40.97	31.84	25.93	18.31	14.40	11.69	9.04	8.59	6.84	5.66	5.52	5.53	6.96
1987	13.04	23.73	29.01	70.56	73.09	67.17	44.33	51.67	48.41	45.67	36.23	26.24	20.33	17.96	28.74	75.20	29.72	15.24	22.40	18.39	20.08	17.57	12.40
1988	6.87	12.66	19.27	16.96	27.29	41.89	46.03	51.67	52.14	46.09	39.09	28.57	21.76	16.39	11.84	8.04	7.10	6.74	5.56	4.99	4.66	4.16	3.85
1989	6.49	11.18	31.91	29.24	76.01	39.71	40.97	45.57	80.63	104.40	42.47	34.00	26.11	20.93	24.61	13.77	10.17	8.59	7.55	6.92	25.78	24.83	20.05
1990	15.71	22.16	44.47	36.04	50.59	36.04	46.03	105.10	52.14	46.29	60.30	80.69	57.31	36.60	26.43	28.80	26.61	13.70	10.78	12.06	6.54	6.01	5.35
1991	17.15	11.59	21.87	23.41	27.29	100.23	114.50	65.08	80.11	73.72	126.50	115.05	86.64	57.97	48.56	25.92	20.45	15.07	14.72	9.94	7.55	5.83	5.35
1992	7.34	7.71	9.81	21.27	31.17	30.35	31.72	36.96	34.92	41.06	40.97	30.16	32.02	23.79	16.30	15.30	10.24	8.59	7.55	6.21	10.86	9.73	6.90
1993	12.01	11.89	11.11	15.27	27.29	80.81	71.60	51.67	52.14	46.09	46.91	34.00	26.11	33.18	34.55	80.12	35.99	23.54	33.74	21.90	19.10	22.27	24.43
1994	11.84	16.84	42.34	24.59	51.14	69.19	65.79	51.67	52.14	46.09	36.74	34.00	26.11	18.05	14.42	12.57	10.17	8.59	7.55	6.21	5.52	5.00	3.98
1995	5.94	7.71	9.81	16.96	109.60	105.20	72.81	110.45	175.00	135.10	149.50	122.60	91.41	62.86	45.79	42.59	28.88	19.24	15.06	12.67	9.43	7.39	6.45

Appendix 3. PRC weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, calculated using data from Alberta Environment (2001). (page 5 of 6)

USTM = St. Mary River at US / Canada Border (Station 05AE27)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	10.57	13.11	12.94	14.88	27.54	43.26	78.77	58.13	56.00	50.93	47.73	44.96	34.15	29.33	30.37	38.77	29.55	29.11	21.60	19.22	14.40	13.34	15.58
1913	11.77	29.17	22.24	18.14	27.54	38.67	46.63	140.00	140.00	127.05	88.56	98.20	71.98	55.26	32.19	33.23	35.08	40.70	34.76	22.59	21.90	17.98	14.91
1914	8.70	17.14	21.17	34.88	40.79	65.59	61.39	49.13	56.00	50.93	47.73	41.77	33.97	35.77	26.09	19.36	17.25	14.76	13.97	18.99	15.40	12.42	11.35
1915	6.72	17.11	17.38	34.41	42.95	38.67	38.40	46.80	56.00	50.93	47.73	51.57	48.24	30.56	34.15	32.14	34.70	26.60	23.94	22.02	17.32	26.33	16.37
1916	15.94	14.17	12.68	19.89	51.68	38.67	46.63	49.13	56.00	89.02	140.00	140.00	140.00	111.90	90.27	56.67	38.35	36.21	35.89	27.48	25.60	38.61	29.18
1917	13.42	7.55	9.18	14.67	27.54	72.77	77.51	95.94	85.76	124.43	119.35	96.35	80.69	73.59	57.85	37.64	24.13	18.08	15.90	17.44	14.17	11.22	11.90
1918	13.76	17.96	17.64	33.75	59.97	42.02	40.66	35.14	56.00	121.98	65.89	41.77	33.09	26.38	22.63	19.36	17.25	16.94	22.08	18.84	16.09	13.52	11.83
1919	5.39	6.45	9.38	32.23	27.54	29.64	65.43	103.30	56.00	49.73	47.73	41.77	33.24	26.38	22.63	18.67	17.25	14.64	12.50	10.52	9.59	9.42	9.01
1920	6.74	15.02	9.18	14.81	27.54	39.87	59.27	49.13	56.00	91.79	93.68	67.17	81.79	58.64	61.12	45.86	31.16	24.30	18.78	15.82	13.45	14.11	14.35
1921	13.34	19.30	14.67	14.94	40.28	53.55	108.30	101.00	111.20	103.70	69.83	71.26	63.05	43.59	35.05	27.68	24.60	19.65	18.72	13.29	12.06	10.39	9.01
1922	4.45	5.69	9.18	20.81	27.54	38.67	102.00	96.91	138.00	101.60	83.43	59.18	40.72	44.42	28.22	19.36	17.25	15.13	12.50	10.62	10.94	11.22	9.01
1923	5.76	8.79	11.55	18.98	39.69	58.60	76.59	91.86	89.79	96.47	62.27	58.11	52.54	31.57	36.31	28.41	21.60	14.64	12.50	28.18	21.41	15.79	12.58
1924	10.81	7.01	9.18	14.88	27.54	71.84	67.47	49.13	63.27	84.19	87.30	55.32	62.01	41.07	22.88	19.36	17.25	16.69	17.49	15.93	16.20	9.42	11.59
1925	25.73	38.97	41.21	35.41	52.36	93.33	140.00	112.05	61.20	66.64	90.44	99.25	68.23	48.07	37.41	24.58	23.20	18.65	19.12	21.47	14.30	14.56	11.67
1926	5.39	25.68	25.73	40.26	28.14	28.29	32.81	25.60	27.74	27.19	33.88	36.57	30.88	26.38	20.49	15.63	14.36	11.85	10.80	10.21	9.59	18.91	20.52
1927	4.84	13.47	33.03	39.93	27.54	66.41	97.60	117.45	119.88	140.00	140.00	138.15	90.19	76.75	65.37	53.83	45.07	31.76	34.17	35.85	22.96	32.27	47.68
1928	7.04	8.65	14.39	30.22	71.61	112.35	127.80	113.40	56.00	50.93	57.70	106.10	109.00	63.39	60.18	45.27	39.59	29.59	21.84	13.58	17.73	17.00	12.84
1929	5.39	7.01	9.18	14.88	27.54	38.67	80.10	51.28	65.83	68.57	47.73	41.77	33.24	26.85	22.63	19.36	17.25	14.64	12.50	10.32	9.59	9.42	7.74
1930	33.78	32.27	53.77	75.57	55.15	38.67	82.55	63.99	56.00	51.06	47.73	41.77	33.24	26.38	22.63	19.36	17.25	14.64	12.50	10.52	9.59	7.82	9.01
1931	5.39	6.39	7.38	16.74	32.07	74.99	46.63	49.13	56.00	50.93	45.20	34.40	26.42	23.41	21.16	17.97	22.18	14.64	12.50	10.52	9.59	9.65	10.34
1932	7.91	11.65	15.08	14.88	42.52	85.67	99.72	49.13	56.00	54.18	78.32	66.62	48.59	28.23	22.63	19.36	17.25	14.64	12.50	11.86	10.81	9.42	9.01
1933	5.39	7.01	11.38	27.32	27.82	38.67	46.63	91.66	114.15	120.60	120.70	78.81	78.18	59.58	43.87	28.94	22.99	20.55	17.95	16.60	13.97	11.42	9.14
1934	32.83	51.01	77.04	88.69	96.22	97.28	68.28	72.93	98.80	88.80	47.73	41.77	33.24	26.38	22.63	19.36	17.25	14.64	12.50	10.52	9.59	9.42	9.01
1935	5.39	13.96	10.63	14.88	27.54	37.31	82.95	72.10	57.73	55.26	47.73	41.77	33.24	28.33	35.92	26.56	19.95	14.64	13.25	10.52	9.59	9.42	9.01
1936	11.13	9.76	25.69	22.37	54.73	90.73	46.63	67.73	56.00	50.93	47.73	41.77	32.24	25.78	20.30	18.11	15.09	12.80	10.56	10.52	9.43	9.04	7.95
1937	5.39	7.01	9.18	16.26	29.99	38.67	46.63	49.13	56.00	140.00	106.10	65.87	46.85	26.53	22.63	19.36	17.25	14.64	12.50	10.52	7.56	9.42	9.01
1938	10.08	20.29	24.42	38.98	27.54	49.19	84.89	125.10	100.60	50.93	73.08	68.84	59.62	35.18	27.59	21.64	17.25	14.64	12.50	10.52	9.59	9.42	10.57
1939	6.82	9.70	30.26	52.00	53.45	61.35	46.63	49.13	51.35	43.09	43.58	41.51	33.24	26.38	22.63	19.36	17.25	14.29	12.50	10.52	9.59	9.42	8.14
1940	5.39	7.57	12.01	15.03	27.54	46.23	46.63	49.13	56.00	50.93	47.73	36.02	26.69	21.70	18.38	17.14	17.25	13.05	10.32	8.76	7.99	9.05	9.01
1941	5.39	7.23	9.66	21.41	27.54	38.67	38.25	48.21	49.81	41.28	33.91	33.18	33.24	25.06	20.38	16.06	12.79	10.91	10.08	9.17	8.22	9.42	11.79
1942	9.79	14.59	34.26	17.74	32.78	38.67	46.63	49.13	101.35	61.93	47.73	41.77	64.79	44.67	34.43	26.86	27.16	22.02	17.08	12.10	10.16	9.42	9.02
1943	23.90	48.20	46.57	38.60	27.54	35.05	51.51	99.82	59.60	72.37	131.50	81.54	95.61	75.15	51.70	51.00	36.92	25.66	17.35	10.90	9.59	9.77	9.01
1944	5.39	5.87	4.22	13.46	21.86	38.67	46.63	46.32	49.27	48.18	41.99	41.77	33.24	24.97	16.72	15.54	14.02	11.68	12.57	13.62	9.59	9.60	9.01
1945	4.35	4.62	3.36	14.88	52.96	55.86	46.63	80.06	103.90	50.94	67.56	69.70	38.31	32.63	23.35	19.36	17.25	14.64	12.50	10.13	8.37	11.78	13.66
1946	5.55	16.39	31.34	35.81	44.07	65.21	55.19	77.65	69.78	51.17	47.73	41.77	34.81	42.14	29.67	20.58	17.25	14.64	12.50	10.52	13.79	12.92	12.91
1947	14.66	27.05	34.52	66.85	94.21	69.24	46.63	49.13	56.00	50.93	47.73	49.68	39.95	43.34	32.70	23.69	17.49	14.64	12.50	14.01	15.14	10.19	9.01
1948	5.39	21.43	19.90	25.76	33.44	38.67	132.65	140.00	140.00	129.60	140.00	100.50	60.50	29.02	22.63	22.25	34.72	21.53	14.33	11.27	14.01	9.42	9.01
1949	6.86	9.21	16.85	21.77	31.22	77.88	63.48	75.11	60.90	50.93	43.09	41.77	32.90	26.38	22.63	19.36	17.25	14.64	12.09	10.52	9.13	9.42	9.01
1950	8.16	11.45	10.36	14.88	24.59	66.38	63.84	74.43	102.30	105.80	139.80	133.90	124.00	86.12	62.81	48.16	43.55	30.94	27.97	22.85	22.04	17.21	12.02
1951	15.09	18.67	21.57	61.18	90.23	103.43	103.80	60.81	55.11	75.63	103.30	118.10	110.34	88.30	89.33	60.62	46.01	34.26	27.69	19.47	30.15	38.76	24.81
1952	11.72	28.63	36.80	55.80	41.12	64.17	66.45	49.13	56.00	50.93	47.73	41.77	37.74	27.39	25.99	25.42	22.02	27.09	26.52	16.23	13.64	9.87	11.60
1953	5.39	7.82	34.52	46.53	59.28	41.24	82.22	140.00	140.00	140.00	99.63	64.08	77.01	81.37	73.40	38.77	28.38	27.55	23.04	18.49	13.91	13.63	11.55
1954	10.57	12.46	9.18	12.67	35.86	106.10	140.00	100.20	72.72	80.06	82.84	110.45	100.56	113.85	74.06	56.00	37.07	30.80	24.89	22.09	34.20	22.69	16.30
1955	5.96	7.01	7.90	13.12	17.93	38.67	58.83	49.13	70.89	108.70	86.47	117.58	42.57	60.41	70.44	45.69	33.52	23.96	16.80	11.61	9.59	9.42	9.01
1956	5.39	10.58	19.00	14.88	25.21	38.67	140.00	140.00	118.80	78.37	80.57	50.59	54.90	57.78	48.36	41.71	30.43	25.29	19.43	13.67	17.03	14.20	10.67
1957	4.74	7.01	9.18	49.87	116.85	99.06	105.55	87.90	106.50	76.34	47.73	41.77	33.24	26.38	22.63	19.36	17.25	14.64	12.50	10.52	9.59	8.38	7.10
1958	7.26	8.92	9.18	14.88	56.93	86.11	95.01	90.67	67.90	71.05	50.35	41.77	33.24	26.38	22.63	19.36	17.25	14.64	12.50	10.52	9.59	9.42	8.83
1959	13.49	17.09	18.29	45.44	34.09	52.12	58.38	49.13	128.20	99.13	94.91	83.33	64.79	48.66	54.58	47.28	27.90	21.29	13.80	14.62	19.37	24.14	34.62
1960	22.01	16.60	11.28	14.88	27.54	54.59	39.65	48.21	89.79	58.08	76.05	43.24	45.43	40.44	33.81	26.44	19.15	20.77	12.98	10.52	9.59	9.42	9.08
1961	9.21	8.64	9.32	14.88	27.54	38.67	91.04	132.00	118.50	86.11	83.26	48.98	33.24	26.38	24.60	21.03	17.25	14.64	12.50	10.52	9.59	9.42	9.01
1962	6.38	23.85	42.29	27.47	27.54	38.67	56.60	64.89	56.00	50.93	63.21	44.65	33.24	26.38	22.63	19.36	22.70	22.08	15.32	10.52	9.59	12.28	11.05
1963	5.48	8.10	9.18	17.91	29.72	38.67	46.63	70.16	98.32	100.32	72.31	47.51	63.12	48.23	27.84	20.18	17.25	14.64	12.50	10.52	9.59	9.16	9.68
1964	2.32	6.02	9.18	19.40	27.54	38.67	74.10	49.13	140.00	140.00	111.43	90.13	70.53	69.30	45.49	28.29	23.56	17.61	13.58	10.52	9.59	15.52	15.37
1965	7.82	10.13	33.80	49.38	31.92	51.41	46.63	69.09	85.76	102.25	134.59	84.67	56.68	64.43	43.43	32.14	28.11	26.38	21.88	18.28	14.93	13.63	12.35
1966	21.75	20.03	14.14	14.88	68.06	38.67	46.63	105.10	108.60	78.65	58.25	43.81	54.46	51.19	38.23	23.29	18.02	15.00	12.50	12.29	14.07	11.64	9.95
1967	5.39	7.01	8.87	8.98	27.54	42.46	119.80	128.50	117.30	111.20	123.40	115.30	86.86	73.09	47.27	33.66	27.76	23.50	19.31	15.55	9.59	9.42	9.01
1968	5.39	7.01	8.94	14.88	27.54	38.67	71.10	70.77	92.93	85.67	58.06	59.93	35.40	47.49	33.18	26.07	19.95	16.82	21.43	19.78	15.94	16.05	16.08
1969	17.75	21.34	36.67	22.99	37.90	64.88	46.63	67.41	77.00	50.93	47.73	102.10	66.51	39.07	22.63	19.36	17.25	14.64	12.50	10.52	9.59	8.55	9.01
1970	4.07	5.44	6.22	14.88	46.82	48.55	86.71	97.54	133.10	131.25	128.60	72.53	35.52	29.04	22.68	19.36	19.01	15.93	12.50	10.52	9.59	9.42	9.01
1971	5.82	6.40	28.39	47.91	78.10	81.89	46.63	108.25	106.50	86.74	60.46	87.14	66.68	53.35	56.71	57.23	41.59	37.74	26.77	17.14	16.90	14.26	9.01
1972	17.99	13.72	13.38	20.95	27.54	78.31	107.30	111.40	140.00	136.70	81.38	53.30	51.73	56.07	71.26	59.48	49.99	41.67	29.25	25.90	20.03	15.34	15.31
1973	5.39	7.01	9.18	13.63	21.77	43.83	74.42	49.13	56.63	69.27	47.73	42.82	33.24	26.38	22.63	19.36	17.25	14.64	12.50	10.52	10.46	9.42	8.47
1974	5.39	8.71	21.83	45.64	56.67	38.67	43.25	67.14	72.79	119.60	140.00	119.65	83.34	69.97	61.83	51.28	37.41	31.43	22.35	18.55	17.19	12.69	12.27
1975	3.73	3.56	7.34	12.14	27.54	68.41	46.63	49.13	138.00	120.20	140.00	140.00	117.80	101.60	67.16	44.74	44.69	28.39	20.85	24.67	28.80	20.96	15.92
1976	20.41	26.91	14.19	20.01	72.56	89.45	60.35	49.13	54.39	50.93	47.73	41.77	41.62	59.82	45.70	41.13	33.52	33.53	28.06	29.34	28.54	18.20	13.97
1977	5.39	7.01	9.94	30.78	28.29	38.67	30.29	30.67	49.44	43.95	33.20	27.96	22.72	17.09	18.49	19.36	17.25	14.64	15.02	17.80	17.55	25.42	22.65
1978	11.97	8.96	11.27	33.12	36.92	54.67	69.63	49.13	79.60	74.72	51.48	70.48	69.91	51.67	53.52	37.14	29.61	21.83	21.05	32.72	22.24	19.79	25.02
1979	8.96	9.18	11.89	29.20	38.86	42.31	85.38	94.93	80.96	57.45	48.26	41.77	33.27	28.11	22.63	19.36	17.25	14.64	12.50	10.52	9.59	9.42	9.01
1980	5.39	11.12	44.94	77.74	63.79	38.67	83.67	97.17	56.00	52.04	52.85	41.77	33.24	26.38	22.63	19.36	17.25	14.64	12.50	16.97	9.59	12.85	14.85
1981	5.39	7.33	22.99	50.96	36.77	51.19	111.50	101.90	65.55	50.93	47.73	46.07	54.00	33.57	28.04	32.68	19.16	15.49	15.50	10.62	9.88	9.42	9.01
1982	5.39	7.01	9.18	14.88	22.18	38.67	70.63	49.13	56.00	96.47	110.50	104.80	84.82	49.37	38.30	26.56	27.76	22.20	18.16	12.81	9.88	9.42	9.52
1983	5.39	7.01	13.76	14.88	26.56	25.84	46.63	75.76	56.00	50.93	47.73	41.77	33.24	33.90	41.04	26.64	19.72	20.25	15.35	10.52	10.53	10.07	9.01
1984	5.01	7.85	15.94	14.88	15.02	35.64	46.63	49.13	56.00	50.93	55.72	67.34	43.92	28.72	22.63	19.36	19.54	18.29	12.50	10.52	9.59	9.42	11.70
1985	8.06	21.00	13.46	43.10	39.39	38.67	78.98	73.58	74.20	59.46	47.73	41.74	33.24	26.38	22.63	19.36	15.95	14.64	12.86	12.53	12.14	15.10	30.54
1986	19.40	15.93	32.25	20.90	27.54	31.01	46.63	120.50	76.58	50.93	47.73	41.77	33.24	26.38	22.63	19.36	17.04	14.64	12.50	10.52	9.59	11.89	14.73
1987	12.18	24.63	27.27	67.82	69.52	68.85	46.63	49.13	56.00	50.93	45.61	30.35	27.70	20.86	22.63	71.57	36.71	17.15	20.50	21.69	18.35	14.70	12.76
1988	13.34	31.46	31.34	17.88	27.54	67.77	46.63	49.13	56.00	50.93	47.73	41.77	33.24	22.30	18.43	16.21	12.97	11.35	11.65	9.60	7.76	6.78	5.93
1989	6.02	23.42	38.47	24.07	79.73	56.54	46.63	46.19	83.61	140.00	63.91	41.95	35.40	34.66	44.08	33.06	21.06	15.35	13.35	20.58	40.45	25.76	17.80
1990	17.14	27.71	51.59	32.08	43.38	38.67	46.63	72.84	56.00	50.93	56.51	75.00	68.81	54.20	39.04	36.73	33.82	22.54	19.99	19.32	14.75	12.17	9.01
1991	17.52	12.05	20.65	17.77	27.54	103.10	140.00	83.55	110.05	109.10	126.70	107.90	105.60	71.74	57.54	39.49	36.71	28.10	23.63	18.14	12.29	9.42	9.01
1992	8.43	13.30	13.89	45.31	48.15	35.90	42.53	49.13	45.40	41.59	47.73	41.77	33.24	26.38	22.63	19.36	16.91	14.64	11.07	9.72	11.77	9.42	9.01
1993	10.37	9.27	9.41	14.88	27.54	73.71	71.99	49.13	56.00	50.80	47.73	41.77	39.58	49.84	40.11	37.02	27.69	16.42	23.78	25.29	17.92	18.48	16.67
1994	12.89	25.43	50.06	27.74	54.24	70.39	46.63	49.13	56.00	50.93	47.73	41.77	33.24	26.38	22.63	19.36	17.25	14.43	12.33	9.00	7.78	6.92	4.89
1995	6.36	7.01	9.18	14.88	44.60	64.53	46.65	71.47	140.00	115.30	91.43	72.92	70.98	60.15	41.74	41.28	29.55	24.58	24.61	20.18	13.01	13.75	11.70

Appendix 3. PRC weekly flows (cms) during the cottonwood growing season (weeks 15 - 37) of 1912 - 1995, calculated using data from Alberta Environment (2001). (page 6 of 6)

LSTM = St. Mary River at Lethbridge (Station 05AE006)

	Week																						
Year	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1912	22.29	24.27	18.77	21.49	34.66	56.61	50.29	52.20	60.41	53.56	50.11	51.00	40.47	46.39	26.47	52.32	56.59	31.81	24.14	20.93	17.26	19.15	17.57
1913	35.39	32.41	32.86	23.70	29.73	36.97	50.29	155.40	143.30	121.65	79.39	80.71	79.29	53.45	31.16	35.72	36.64	36.29	37.34	26.99	23.93	19.87	16.23
1914	8.82	16.89	25.38	40.89	44.46	40.01	51.27	52.20	60.41	53.56	50.11	42.19	36.64	45.26	33.21	20.39	24.07	17.86	16.00	25.99	19.88	17.14	14.84
1915	8.94	14.08	19.27	33.07	49.05	71.00	50.29	50.63	85.17	53.56	52.97	70.75	57.31	44.64	37.06	59.31	50.86	32.23	27.94	30.66	22.04	30.26	27.10
1916	16.17	15.00	16.05	21.14	52.29	36.97	50.29	63.89	62.99	103.45	180.00	166.10	172.85	137.85	97.66	66.88	57.94	51.88	43.16	37.19	30.09	39.60	38.73
1917	44.99	19.19	15.03	18.06	22.49	74.27	94.09	115.75	104.50	136.70	128.57	105.50	81.29	77.21	57.38	41.67	29.26	29.50	25.76	20.17	19.77	14.64	13.47
1918	13.30	19.80	19.57	26.13	77.91	67.42	49.11	39.71	51.00	127.40	92.07	42.19	35.73	28.10	23.40	19.30	18.14	16.76	23.14	17.99	14.64	12.86	11.47
1919	6.05	7.56	11.78	25.41	29.73	31.59	54.74	101.90	60.41	51.81	50.11	42.19	36.64	28.10	23.40	17.26	18.14	13.19	12.13	10.21	9.10	8.75	8.57
1920	15.77	32.07	14.17	18.06	51.85	69.30	71.07	52.20	60.41	83.37	101.10	74.50	85.96	64.52	65.16	48.78	29.15	20.70	20.78	15.87	13.25	11.87	15.29
1921	10.85	25.50	21.80	18.06	35.53	40.62	101.90	101.30	111.35	115.40	70.69	76.97	64.60	42.39	30.90	26.80	22.91	16.28	15.08	12.94	10.83	9.58	8.75
1922	4.29	8.64	12.56	38.77	29.73	36.97	101.90	97.56	121.40	104.65	92.76	68.06	44.00	55.16	36.93	30.85	18.14	16.09	14.06	12.36	12.00	11.14	9.73
1923	6.90	9.21	12.56	18.06	29.73	50.99	59.14	79.63	102.70	107.90	84.30	62.57	52.67	33.50	38.99	28.24	23.63	13.19	13.33	25.03	21.07	18.51	15.84
1924	11.36	9.21	10.54	16.13	29.73	70.27	72.74	52.20	60.41	104.00	98.87	84.93	65.93	52.49	23.99	17.42	18.59	19.59	21.60	17.73	15.17	10.70	10.13
1925	38.66	51.39	56.21	48.81	54.41	96.49	148.85	114.30	62.03	58.98	95.11	92.47	68.84	45.96	36.89	24.99	24.13	17.67	17.63	19.68	14.10	13.84	11.06
1926	6.05	21.34	27.29	35.63	29.73	26.80	30.79	24.00	23.26	25.19	37.13	37.46	31.21	25.70	19.60	15.23	14.37	12.60	11.24	10.21	9.10	21.10	22.11
1927	6.05	10.17	35.51	51.92	40.56	72.43	156.40	180.00	142.00	176.13	174.00	150.60	92.98	87.01	70.06	61.46	46.76	33.73	35.72	42.94	26.59	29.68	52.09
1928	10.51	12.41	17.74	34.14	75.90	117.50	115.95	124.00	60.41	53.56	72.07	119.00	153.40	79.21	76.39	49.63	49.50	33.40	21.84	16.51	26.00	19.27	15.78
1929	6.16	10.98	14.44	18.06	29.73	37.77	81.36	71.00	81.84	69.01	50.11	42.19	36.64	30.55	23.40	17.26	18.14	13.19	12.13	10.21	9.10	8.75	8.57
1930	32.37	35.69	49.89	71.24	63.11	38.48	59.43	52.20	60.41	54.19	50.11	42.19	36.64	28.10	23.40	18.50	18.14	13.19	12.13	10.21	9.10	8.45	8.57
1931	6.05	6.32	7.84	18.06	29.73	68.64	50.29	52.20	60.41	53.56	43.41	35.29	26.93	23.34	20.79	17.26	18.14	13.36	12.13	10.21	9.10	8.75	9.91
1932	9.26	12.91	26.10	18.06	40.49	81.13	105.40	52.20	60.41	53.56	74.89	63.49	49.41	29.94	23.40	17.73	18.14	13.19	12.13	11.37	12.62	8.75	8.57
1933	6.05	9.21	13.21	25.78	41.88	37.40	50.29	90.35	127.60	125.70	126.30	83.13	77.29	62.99	43.97	29.53	22.40	19.44	17.14	17.46	13.61	10.70	8.57
1934	31.33	47.38	88.29	65.60	116.21	97.63	76.83	78.10	102.00	117.15	50.11	42.19	36.64	28.10	23.40	17.26	18.14	13.19	12.13	10.21	9.10	8.75	8.57
1935	5.42	30.54	12.67	18.06	29.73	35.47	80.91	72.80	60.41	55.69	50.11	42.19	36.64	29.02	32.71	27.27	21.25	13.67	14.44	10.21	9.10	8.75	8.57
1936	24.29	11.00	23.13	22.19	49.97	83.19	50.29	52.20	61.28	53.56	50.11	42.19	34.10	24.90	19.53	17.11	14.04	12.40	10.27	10.21	9.10	8.75	8.57
1937	10.51	9.21	12.56	18.06	29.73	36.97	50.29	52.20	60.41	153.60	109.70	71.74	48.11	28.10	23.40	17.26	18.14	13.19	12.13	10.21	8.52	8.75	8.57
1938	20.20	18.07	30.69	40.52	31.39	43.21	86.99	130.20	111.60	53.56	65.45	73.35	64.09	38.13	28.87	20.64	18.14	13.19	12.13	10.21	9.10	8.75	8.77
1939	6.73	9.21	24.67	52.27	53.16	43.12	50.29	52.20	56.00	48.07	47.29	41.07	36.64	28.10	23.40	17.26	18.14	13.19	12.13	10.21	9.10	8.75	8.29
1940	6.05	9.21	16.33	18.40	29.73	42.45	50.29	52.20	60.41	53.56	49.03	38.29	26.69	22.30	17.70	16.33	18.14	13.19	10.18	8.69	8.05	8.03	8.57
1941	6.05	9.21	12.56	20.51	29.73	36.97	40.50	52.20	60.41	45.10	38.40	33.98	36.64	27.56	21.57	16.96	13.61	10.35	10.15	9.19	8.88	8.75	10.13
1942	10.21	14.58	33.63	19.57	29.73	41.57	50.29	64.82	121.78	80.06	50.11	47.97	62.26	48.52	37.40	31.34	30.68	26.06	20.14	13.57	10.27	9.94	8.57
1943	28.31	42.94	53.01	43.69	32.83	36.97	50.20	105.94	77.93	78.44	143.30	111.55	117.90	91.89	60.64	58.39	39.39	28.06	17.48	12.04	9.36	9.33	8.57
1944	6.05	6.20	4.29	8.97	18.64	31.76	50.29	42.90	48.73	47.29	43.63	42.19	36.64	28.10	16.99	15.01	13.43	11.63	12.13	14.91	9.10	9.10	8.57
1945	5.14	5.41	4.78	11.86	41.01	58.65	50.29	77.11	133.00	73.77	68.65	89.46	50.44	32.50	26.25	17.26	18.14	13.19	12.13	10.21	8.58	8.75	12.90
1946	6.05	11.75	24.73	39.48	43.58	55.71	50.29	86.04	73.60	53.56	50.11	42.19	36.64	41.22	29.36	19.31	18.14	13.19	12.13	10.21	12.39	11.31	12.43
1947	14.11	30.02	35.37	70.31	85.59	78.47	50.29	52.20	60.41	53.93	50.11	47.38	39.66	42.97	33.70	21.84	18.14	13.19	12.13	12.69	15.54	15.56	13.39
1948	6.05	61.93	37.17	28.93	55.91	36.97	125.40	160.70	169.10	136.70	180.00	93.59	60.71	34.17	24.01	25.22	34.67	22.02	17.14	12.86	13.13	10.08	8.57
1949	11.96	10.27	16.02	21.50	29.73	77.72	74.10	82.29	60.70	53.56	50.11	42.19	34.83	28.10	23.40	17.26	18.14	13.19	11.94	10.21	9.10	8.75	8.57
1950	12.39	23.07	14.11	18.06	27.51	69.63	66.06	86.04	106.49	119.90	152.45	134.00	124.70	98.42	67.95	55.72	43.99	35.82	25.84	22.27	21.81	16.00	12.08
1951	26.54	26.17	32.69	97.78	100.30	132.40	110.90	68.01	60.41	89.19	106.45	180.00	136.50	113.10	106.05	62.77	52.37	41.14	31.97	23.00	51.35	49.05	39.87
1952	24.97	36.77	44.70	56.49	56.75	64.86	68.42	52.20	60.41	53.56	50.11	42.19	38.95	29.87	29.57	29.70	19.19	30.10	28.93	19.37	15.91	13.00	13.13
1953	6.70	10.97	60.31	62.76	86.40	37.41	86.74	172.10	180.00	180.00	124.10	58.51	82.57	92.93	66.50	41.44	31.97	33.68	38.58	13.37	11.16	10.19	11.47
1954	19.70	17.17	12.56	13.46	34.97	113.50	175.14	107.92	84.00	81.97	72.90	114.80	95.93	104.40	81.62	62.27	37.71	32.16	26.13	24.10	38.17	25.00	19.06
1955	19.09	9.21	12.56	18.06	26.17	50.87	104.20	62.48	80.21	125.70	97.28	117.94	41.38	65.67	72.00	57.79	41.16	27.32	19.69	11.78	10.65	8.75	9.96
1956	6.36	12.29	21.43	18.06	29.73	36.97	135.05	151.15	116.40	63.63	77.87	46.59	75.27	51.58	62.10	47.93	28.81	27.90	22.05	15.33	18.06	14.97	8.97
1957	5.55	9.21	12.56	42.30	124.85	108.40	106.60	93.74	105.40	79.96	50.11	42.19	36.64	28.10	23.40	17.45	15.43	13.19	12.13	10.21	9.10	8.75	8.57
1958	34.70	13.87	12.56	18.06	51.27	104.10	90.07	92.69	71.78	79.29	62.16	42.20	36.64	28.10	23.40	19.09	18.14	13.19	12.13	10.40	9.10	7.90	8.57
1959	24.42	26.38	24.40	46.60	38.40	48.60	65.16	52.20	117.60	91.64	102.10	96.13	53.93	50.00	48.86	43.79	29.63	19.89	14.46	18.74	19.17	19.70	36.44
1960	25.61	22.05	14.32	18.06	29.73	63.96	49.34	48.59	76.61	60.74	69.53	44.97	48.79	37.53	35.00	26.20	23.07	24.47	12.13	10.21	9.10	8.75	11.73
1961	8.65	9.21	12.56	16.13	29.73	36.97	87.40	146.10	123.40	94.82	87.38	51.00	36.64	28.10	24.09	20.37	18.14	13.19	12.13	10.21	10.59	11.71	8.13
1962	8.61	24.43	45.16	35.24	29.73	36.97	52.59	56.49	60.41	53.56	65.08	46.63	36.64	28.10	23.40	19.05	19.68	27.78	17.17	10.21	9.10	11.24	9.98
1963	7.73	9.93	12.56	18.06	29.73	36.97	50.29	66.99	88.49	105.20	84.30	69.66	69.79	39.57	23.98	21.27	18.14	13.19	14.21	10.21	9.10	5.46	8.57
1964	6.05	9.21	12.56	70.72	72.63	47.07	83.05	52.20	180.00	180.00	115.85	89.09	73.69	68.36	46.29	31.57	25.84	19.44	14.72	10.21	9.10	17.38	16.42
1965	23.61	19.00	36.11	55.68	33.76	61.56	59.07	77.36	91.95	110.50	158.85	126.60	70.46	80.53	48.09	42.33	26.40	30.38	23.00	17.13	14.57	12.48	13.78
1966	23.62	25.66	17.08	18.06	61.84	41.87	50.29	100.60	151.30	101.85	63.48	52.97	65.51	57.76	43.45	25.87	18.59	15.42	14.06	17.23	18.46	12.71	9.49
1967	10.01	9.41	12.56	18.06	91.42	108.40	145.00	141.65	140.15	127.60	130.00	107.60	91.03	73.25	65.61	37.45	28.46	25.00	15.25	19.63	9.10	8.75	8.57
1968	6.37	9.21	12.41	18.06	29.73	36.97	75.54	76.32	99.53	100.50	50.31	56.02	44.79	47.00	32.33	26.84	27.14	18.09	18.32	28.49	14.96	17.93	16.73
1969	33.99	29.84	40.26	30.83	38.14	72.07	50.29	71.57	96.70	57.97	50.11	137.79	78.22	31.68	23.40	20.00	19.96	13.19	10.40	7.08	5.48	8.75	8.57
1970	6.05	7.09	6.65	16.50	43.19	66.34	95.53	104.20	135.70	149.05	135.70	66.45	38.51	31.42	27.67	20.10	25.48	13.21	12.13	10.21	9.10	8.53	9.37
1971	7.82	9.23	29.81	45.30	80.26	88.57	50.29	119.40	113.20	90.56	61.09	83.60	66.23	54.23	47.27	53.44	43.01	38.00	23.52	16.87	14.26	15.37	8.57
1972	30.96	16.13	15.86	25.08	29.73	79.29	110.90	120.85	161.95	172.90	93.63	54.13	59.93	59.93	77.50	71.79	53.84	46.26	34.89	30.60	20.79	16.93	16.14
1973	6.05	9.21	12.56	16.63	24.53	40.38	85.40	52.20	60.41	68.19	50.11	42.19	36.64	28.10	23.40	17.26	18.14	13.19	12.13	9.83	9.10	8.75	5.64
1974	7.21	10.48	34.49	60.19	59.86	36.97	42.11	52.20	90.29	106.10	156.89	121.35	87.76	67.24	65.40	50.31	41.75	28.93	26.02	20.52	16.90	11.42	12.62
1975	3.12	9.21	64.64	48.02	69.74	78.77	64.84	52.20	138.00	112.35	180.00	159.40	122.29	134.50	79.26	40.46	43.36	28.81	15.90	21.84	28.28	23.16	18.44
1976	17.72	27.44	16.84	24.56	75.34	104.10	78.11	52.20	60.41	53.56	50.11	45.28	39.26	62.15	46.08	39.93	30.01	42.89	29.86	28.09	28.61	15.86	17.37
1977	8.05	7.82	11.37	18.76	29.73	36.97	29.01	26.71	42.59	42.13	29.50	21.79	20.40	14.40	15.11	16.40	18.14	13.19	12.13	14.45	14.40	22.01	18.90
1978	9.66	11.31	12.56	28.07	42.38	57.56	66.87	52.20	69.43	70.14	51.80	74.96	78.54	56.57	53.30	39.31	29.06	20.33	16.37	33.93	31.53	21.83	30.24
1979	29.29	26.81	24.10	39.76	58.27	54.64	93.51	109.66	74.47	58.77	54.77	42.19	36.64	28.10	23.40	17.45	18.14	13.19	12.13	10.21	9.25	8.75	8.57
1980	6.32	15.86	37.37	76.40	63.67	36.97	74.75	134.70	60.41	80.61	77.39	42.19	36.64	28.10	23.40	17.26	18.14	12.52	12.13	15.33	11.04	8.94	10.45
1981	6.05	9.21	20.33	51.37	49.37	95.16	180.00	87.81	69.08	102.60	50.11	45.39	52.06	35.91	24.20	35.06	22.54	17.19	14.39	10.21	9.10	8.75	8.23
1982	49.21	24.74	12.56	17.20	23.31	36.97	57.17	71.33	60.41	87.34	102.60	98.29	89.07	60.81	43.16	33.71	27.69	23.26	16.41	10.21	9.10	8.75	6.74
1983	2.96	8.66	12.56	18.06	27.37	27.73	50.29	78.85	60.41	53.56	49.24	42.19	36.64	29.79	43.69	29.31	18.70	13.91	12.13	10.21	9.10	8.75	8.57
1984	5.90	9.21	15.83	18.06	13.73	28.63	50.29	52.20	56.76	48.16	50.11	60.94	46.34	29.05	23.40	17.26	18.14	13.19	12.13	10.21	7.97	6.88	8.57
1985	7.38	16.77	15.49	28.58	38.67	36.97	61.43	75.13	66.64	57.85	50.11	42.19	36.64	28.10	23.40	16.17	15.61	9.58	12.66	14.16	9.10	13.84	32.40
1986	14.55	15.68	32.34	22.71	29.73	34.87	50.29	110.60	93.38	53.56	50.11	41.20	36.64	28.10	23.40	17.26	18.14	13.14	12.13	5.52	9.10	8.75	10.60
1987	12.90	25.96	28.79	69.47	65.93	73.05	47.94	52.20	55.86	53.56	50.11	36.79	36.64	25.17	23.40	81.70	39.54	22.84	21.84	23.65	24.97	13.92	14.04
1988	9.17	28.02	35.24	18.25	29.73	54.64	50.29	52.20	60.41	53.56	50.11	42.19	30.51	18.13	13.86	8.07	8.56	8.01	8.49	8.53	3.63	2.35	5.09
1989	10.30	24.97	35.81	26.62	78.57	62.45	50.29	48.36	84.25	164.93	65.79	43.50	36.64	30.36	44.56	32.73	20.63	16.54	12.99	10.49	37.46	37.02	20.44
1990	16.79	31.03	57.89	41.50	47.86	36.97	50.29	96.30	60.41	53.56	58.61	78.04	70.85	54.56	39.99	36.81	32.63	23.46	19.26	13.13	16.30	12.38	8.07
1991	16.42	12.47	22.12	18.80	29.73	85.52	165.05	95.40	108.90	109.10	140.85	132.25	98.11	69.29	55.31	38.97	36.07	31.10	30.26	16.66	12.83	8.75	8.57
1992	6.53	10.84	12.78	32.53	35.23	34.53	34.04	45.13	42.30	34.67	50.11	42.19	36.64	28.10	23.40	18.21	18.14	13.19	12.13	9.59	12.81	8.75	8.57
1993	15.40	12.83	13.75	18.06	29.73	76.91	69.59	52.20	60.41	53.56	50.11	42.19	41.93	88.96	66.86	59.70	36.43	20.49	40.74	31.19	21.21	24.32	23.43
1994	13.67	26.57	48.63	38.63	53.01	75.71	85.94	52.20	60.41	53.56	50.11	42.19	36.64	28.10	23.40	17.26	15.57	13.19	10.69	2.34	2.35	2.35	2.35
1995	3.58	9.21	12.56	18.06	107.65	91.68	85.76	93.25	180.00	140.00	103.70	104.00	111.60	67.36	44.68	51.64	37.15	23.96	22.19	21.55	10.44	11.63	14.81